SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST, 1929.

GENERAL PHYSICS.

2331. New Self-Adjusting Pipette. E. G. Bilham. *Journ. Sci. Instruments*, 6. *pp.* 119–120, *April*, 1929.

By means of an inner tube forming an extension of the ordinary discharge jet of a pipette, a fixed quantity of liquid is retained and can be recovered by pouring out from the top of the pipette. Pipettes of this pattern have been found useful for purposes where definite fixed quantities of water or other liquid have to be measured rapidly and accurately.

AUTHOR.

2332. Baker Automatic Release for Dropping the Meteorograph from a Registering Balloon at a Predetermined Height. L. H. G. Dines. *Roy. Meteorolog. Soc., J.* 55. *pp.* 117–121; *Disc.* 121–122, *April*, 1929.

A detailed description of the release, which depends essentially on an aneroid, is given. Its weight is 25 gr., and it is hung between the balloon and meteorograph. Out of 17 occasions (for heights of from 4 to 13 km.) on which it had been used and the meteorograph recovered, the record showed that release occurred within about 2 km. or less of the predetermined height.

C. A. S.

2333. Complex Pendulum Driven by Two Pendulums having Commensurate Periods. H. M. Browning. *Phil. Mag.* 7. *pp.* 721–729, *April*, 1929.

A complex pendulum consisting of a wire carrying two loads at different distances from the point of suspension is forced into vibration by connection with two other simple pendulums, the relative periods of which can be varied. The response is observed by means of a fine stream of salt falling from the bob of the pendulum on to a moving board. The types of response obtained under varying impressed conditions are tabulated.

A. A. D.

2334. Magnitude of Non-Dimensional Constants. W. N. Bond. *Phil. Mag.* 7. *pp.* 719–721, *April*, 1929.

Numerical constants appearing in about 700 physical equations have been tabulated and a distribution curve plotted. The following hypothesis best fits the observations: That the constants less than unity are distributed in value uniformly between zero and unity (with the corresponding distribution of the reciprocals between unity and infinity).

A. A. D.

2335. Effect of Pressure on the Rigidity of Steel and Glass. P. W. Bridgman. *Am. Acad., Proc.* 63. *pp.* 401–420, *Feb.*, 1929.

The sliding contact potentiometer, developed for the purpose of measuring very small displacements, is used to examine the variation in length of suitably loaded springs immersed in pressure baths. From the change in length, the alteration in the modulus due to pressure can be calculated. In the early experiments the differential effect between glass and steel was measured, the assumption being made that pressure did not affect the modulus for steel. This assumption was subsequently found to be unjustified and absolute methods were developed. Full experimental details are given and the necessary corrections (some of which are large) are considered at length. For steel the modulus increases with pressure, and for glass it diminishes. The paper contains also some experimental results on the variation of the compressibility of glass with pressure and some calculated results of the effect of pressure on other elastic constants such as Poisson's ratio. A. A. D.

2336. Elastic Properties of Wool in Water at High Temperatures. J. B. Speakman. *Faraday Soc., Trans.* 25. *pp.* 169–176, *April*, 1929.

The conditions which determine the rate of recovery of wool fibres from strain, and their ability to assume permanent set, have been determined. True permanent set is not realised in water below 90° C. The fibrillar structure of the wool fibre does not melt or dissolve in water at elevated temperatures. Wool fibres made more amorphous by plastic flow are able to undergo some form of internal rearrangement (recrystallisation), accompanied by contraction, in water at high temperatures. This property is responsible for the disappearance in hot water of " set " which was permanent in cold water. AUTHOR.

2337. Damped Transversal Vibration of Prismatic Bars. K. Suyehiro. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 63–70, *March*, 1929. *In English.*

The resistance to free transversal vibrations is composed of (1) air resistance, and (2) internal resistance due to solid viscosity of the material or to its internal friction. The former is negligibly small, and not further considered. The author takes the case of a uniform straight bar with a longitudinal plane of symmetry and an expression is obtained for the transversal vibrations parallel to this plane. The upper limits of frequency of the unresisted vibration are obtained. From the results obtained, the nature of the free vibrations of framed structures, towers, chimneys, etc., can be inferred. R. S. R.

2338. Theory of Elastic Oscillations. D. Graffi. *N. Cimento*, 5. *pp.* 310–317, *Aug.-Sept.-Oct.*, 1928.

The theory of elastic oscillations is treated in this mathematical paper with consideration of rigidity and viscosity. With a suitable form of the coefficient of rigidity, the solution of the integro-differential equations assumes a relatively simple form. To compare the results with experiment the expression for the logarithmic decrement of the oscillation was sought for. This expression was found by making some simplifications, and with it is explained the dependence of the decrement on the period, but not its dependence on the amplitude. The author considers that his method of resolving the integro-differential equations may be useful in other branches of physics, *e.g.*, in the study of the discharge of a condenser with dielectric hysteresis. J. J. S.

2339. Hamilton's Principle. T. Levi-Civita. *Accad. Lincei, Atti,* 9. *pp.* 44–48, *Jan.* 6, 1929.

Mathematical. Shows how Hamilton's principle may be written so as to satisfy two conditions: (1) that the invariance shall be evident of the integral whose variations are to be annulled by an invertible substitution in the variable of integration; and (2) that the system of Euler equations expressing the annulment of the variations of the integral shall be converted into an equivalent when there is executed under the integral an invertible substitution in a system of 4 coordinates consisting initially of the three Cartesian coordinates and the time. A. D.

2340. Conditions for the Validity of Hamilton's Principle. Z. Horak. *Comptes Rendus,* 188. *pp.* 614–616, *Feb.* 25, 1929.

In deducing Hamilton's principle it is always supposed that the operators *d* and δ, corresponding to the real movement and to the virtual displacement, applied to the parameters x^λ are exchangeable. It is necessary to emphasise the fact that this should not be assumed simultaneously for all these parameters; it is shown, however, that the above supposition is not required, and the condition necessary and sufficient for the validity of the principle is derived. H. N. A.

2341. Resistance to Motion of a Lamina. H. Lorenz. *Phys. Zeits.* 30. *pp.* 201–203, *April* 1, 1929.

Develops mathematically the resistance to motion of a lamina in an infinite resistive medium. The case of a thin circular plate moving axially is developed from the general treatment. G. E. B.

2342. Dynamical Actions in a System of Rectilineal Vortices. A. Masotti. *Accad. Lincei, Atti,* 9. *pp.* 301–304, *Feb.* 17, 1929.

Mathematical theorems, leading to a simple method of determining the dynamical actions. A. D.

2343. Fundamental Problem in the Theory of Vortex Motion. H. Villat. *Comptes Rendus,* 188. *pp.* 837–839, *March* 18, 1929.

A fundamental and classic theorem is that the velocity in an infinite liquid can be calculated from the distribution of vorticity. If the liquid is contained in a rigid boundary, Poincaré's investigations seem to demand also the knowledge of the velocities over the boundary. It is shown that this is not necessary, as it is possible to deduce an integral equation of Fredholm's type for these velocities, involving the vorticity. W. G. B.

2344. Double Row of Vortices with Arbitrary Stagger. L. Rosenhead. *Cambridge Phil. Soc., Proc.* 25. *pp.* 132–138, *April,* 1929.

The only arrangement of equally spaced double rows of vortices which is stable is the Karman " vortex street." W. G. B.

2345. Alternate Vortices in a Canal of Finite Width. H. Villat. *Comptes Rendus,* 188. pp. 1129–1132, *April* 29, 1929.

On working out the theory of a double row of vortices in a canal of finite breadth a formula for the resistance is obtained, in the same way as by Karman. It appears, however, that on letting the width tend to infinity, the limiting formula differs from Karman's. The difference is explained as being due to the fact that in the canal the flow must be the same at all sections, while there is no similar condition imposed when we deal with an infinite fluid. W. G. B.

2346. Vortex Theory of Screw Propellers. S. Goldstein. *Roy. Soc., Proc.* 123. *pp.* 440–465, *April* 6, 1929.

The potential problem of a helical vortex sheet is worked out exactly, and applied to the evaluation of thrust, torque and efficiency, the distribution of circulation along the blade being determined by the usual condition that the rate of energy loss in forming the trailing vortices is a minimum. Comparison is made with Prandtl's approximate solution, and tables for facilitating computation are included. W. G. B.

2347. Steady Motion of Viscous Incompressible Fluids; with Particular Reference to a Variation Principle. C. B. Millikan. *Phil. Mag.* 7. *pp.* 641–662, *April*, 1929.

Except in exceptional cases, it is not possible to represent the motion of a viscous incompressible liquid by means of a variation principle, but all cases of such motion that have yet been discovered belong to this class of "exceptional cases." The appropriate functions are given. W. G. B.

2348. Streamline Flow through Curved Pipes. C. M. White. *Roy. Soc., Proc.* 123. *pp.* 645–663, *April* 6, 1929.

C, a numerical coefficient, defined as $Fd/8\mu v$, representing the increase of resistance due to curvature; d, diameter of pipe; D, mean diameter of coil; d/D, curvature-ratio; F, intensity of frictional drag on wall of pipe, *i.e.*, shear stress at boundary; g, gravitational acceleration; m, hydraulic mean depth = area/perimeter; v, mean velocity of flow = volume flowing per unit of time/cross-sectional area of the pipe; ρ, density of fluid; μ, viscosity of fluid. The loss of head h in a length l of coiled pipe of diameter d, in which the mean velocity of flow is v, may be expressed by the equation

$$h = C \cdot 8\mu/\rho v d \cdot 4lv^2/gd,$$

where μ/ρ is the kinematic viscosity of the fluid, and where the numerical coefficient C depends on both the flow and the curvature. The value of C is given by the empirical equation

$$C^{-1} = 1 - [1 - (11 \cdot 6/\kappa)^x]^{1/x},$$

where $\kappa = \rho v d/\mu \cdot (d/D)^{1/2}$ and $x = 0 \cdot 45$. A. D.

2349. Form and Size of the Lattice of Cellulose and Caoutchouc. J. Hengstenberg and H. Mark. *Zeits. f. Krist.* 69. 3–4. *pp.* 271–284, *Dec.*, 1928.

The grounds underlying the Röntgen-ray determination of size and form of the lattice according to Laue principles is discussed and experimentally investigated. The measurements indicate that cellulose, artificial silk, and caoutchouc have long extended cells in the direction of the thread axis. It is also shown from the rise of temperature of the liquid air that the coefficient of expansion in a direction parallel to the thread axis is substantially smaller than that at right angles. J. K.

2350. Lattice Constants of Barium Telluride. V. M. Goldschmidt. *Zeits. f. Krist.* 69. 5–6. *pp.* 411–414, *Feb.*, 1929.

Three different samples have been measured by different observers; the values for a are 6·986 ± 0·002 Å., 6·986 ± 0·002 Å. and 6·984 ± 0·002 Å. These values differ from those obtained by Haase, 6·82 and 6·86 Å.; this seems to be due to his use of sodium fluoride as comparison substance, the degree of absorption of which for X-rays is very greatly different from that of barium telluride. In the present measurements rock-salt was used.

H. N. A.

2351. Crystal Structure of Anhydrous Alums R′R″$(SO_4)_2$. L. Vegard and A. Maurstad. *Zeits. f. Krist.* 69. 5–6. *pp.* 519–532, *Feb.*, 1929.

The following alums have been worked with: $KAl(SO_4)_2$, $KCr(SO_4)_2$, $NH_4Al(SO_4)_2$, $NH_4Fe(SO_4)_2$. At first the water-free alums obtained by heating gave bad powder diagrams without sharp lines. When the $KAl(SO_4)_2$ powder was heated for a certain time the individual crystals became larger, and good diagrams were obtained. A similar heating of the $KCr(SO_4)_2$ powder had little effect, and the ammonium compounds were decomposed by heating, giving off NH_3. A study of the intensity of the lines led to the space group D_3^2, the coordinates of the different atoms being calculated, and diagrams are given showing their positions. The following atomic radii are calculated: K^+ 1·36 Å., Al^{+++} 0·82 Å., O^{--} (within the SO_4 groups) 1·33 Å., O^{--} (contact between different SO_4 groups) 1·41 Å., S^{+6} 0·31 Å. H. N. A.

2352. Crystal Structure, Lattice Constants and Density of Rhenium. V. M. Goldschmidt. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 244–252, *Feb.*, 1929.

Structure type, hexagonal with tightest packing, with an axial rotation coming very near the ideal case for spheres with tightest packing $a = 2 \cdot 752 \pm 0 \cdot 001$ Å., $c = 4 \cdot 448 \pm 0 \cdot 002$ Å., $c/a = 1 \cdot 616 \pm 0 \cdot 001$ Å., density $= 21 \cdot 40 \pm 0 \cdot 06$; this density lies evenly between the values for the two neighbouring elements, tungsten, density 19·30, and osmium, density = 22·72, though tungsten has a different crystalline structure. The atomic radii of the elements from Hf (72) to Au (79) have been calculated and plotted against the atomic numbers; the graph falls from hafnium to osmium, and then rises until gold is reached. H. N. A.

2353. Alleged Sesqui-Sulphide of Molybdenum. V. Montoro. *Accad. Lincei, Atti,* 9. *pp.* 331–337, *Feb.* 17, 1929.

Shows, by crystal-structure methods, that the alleged sesqui-sulphide of molybdenum does not exist. A. D.

2354. The Spinels. L. Passerini. *Accad. Lincei, Atti,* 9. *pp.* 338–343, *Feb.* 17, 1929.

Experimental data of crystal-structure investigations into various spinels. A. D.

2355. Flow of Metallic Crystals under Torsion. R. Karnop and G. Sachs. *Zeits. f. Physik,* 53. 9–10. *pp.* 605–618, 1929.

Results are given of torsion experiments on a number of improved crystals of an aluminium-copper alloy containing 5 % of copper [see Abstract 2904 (1928)]. The force necessary to produce permanent deformation amounting to 0·2 % varies with the orientation of the crystal in the proportion 2·2 (cubic) : 1 (octahedral). This result agrees qualitatively with the value 1·85 : 1, calculated on the assumption of a flowing surface layer. The discrepancy probably depends on peculiarities of the slipping processes for particular orientations. The calculated elastic limits of the crystals vary within the narrower limits 1·73 : 1, and the experimental results are in good qualitative agreement therewith. The elastic constants are comparatively slightly dependent on the orientation. T. H. P.

2356. Parallel Growths of Fahlerz [Tetrahedrite] and its Chemical Constitution. W. W. Nikitin. *Zeits. f. Krist.* 69. 5–6. *pp.* 482–502, *Feb.*, 1929.

The author considers that the view that fahlerze are crystal solutions of sphalerite and often of the sulphoferrites of copper in a normal orthosulpharsenite or sulphantimonite of Cu′, Ag′, Zn″, Fe″, is as acceptable as Prior and Spencer's formula. The presence of small quantities of mercury in the compound (Zn, Fe) S is also possible, and the composition of most of these minerals may be represented by the formula $(As, Sb, Bi)_2\ S_6\ (Cu_2, Ag_2, Zn, Fe, Hg)_3 + x\ (Zn, Fe, Hg)\ S$, the value of x varying between 0·18 and 0·91. In seven out of the 25 analyses available, however, the composition is expressed by the formula $(As, Sb, Bi)_2\ S_6\ (Cu_2, Ag_2, Zn, Fe, Hg)_3 + x\ (Zn, Fe, Hg)\ S + y\ Fe_2S_3Cu_2S + z\ Cu_2S$. In this case the content of sphalerite often falls to zero. In the analyses considered the content of sulphoferrites does not exceed 0·27 for Fe_2S_3, Cu_2S, and 0·11 for Fe_2S_3, $3Cu_2S$. T. H. P.

2357. Calculation of the Flow Limits of Mixed Crystals on the Basis of the Plasticity of Mono-Crystals. A. Reuss. *Zeits. f. angew. Math. u. Mechanik,* 9. *pp.* 49–58, *Feb.*, 1929.

Recent investigations on the flow limits of mono-crystals give rise to the question whether the properties of such crystals permit of immediate conclusions concerning the behaviour of chemically homogeneous bodies constructed from them. In this mathematical paper, calculations of the flow limits for mixed crystals of the regular, hexagonal, and triclinic systems are made on the basis of various assumptions. The results of the calculations show that, if the corresponding data for the mono-crystal are available, it is possible to follow numerically the behaviour of the quasi-isotropic mixed crystals from the beginning of the deformation process through the region of elasticity as far as the lower limit of flow. T. H. P.

2358. Possible Asymmetry of Corrosion Figures Produced by an Active Isotropic Liquid. L. Royer. *Comptes Rendus,* 188. *pp.* 1176–1178, *April* 29, 1929.

The etching action on the six rhombohedral faces {100} of calcite by solutions of the different tartaric acids has been examined. The figures produced by racemic and mesotartaric acids are symmetrical, those by d- and l-tartaric acids asymmetrical with respect to the perpendicular plane of symmetry (P), the figures in the latter case being enantiomorphous. Opposite faces, *e.g.* (100) and ($\bar{1}00$), are similarly etched. Similar results were obtained with the various malic, aspartic, gluconic, camphoric, glyceric, pyruvic and mucic acids, and with alanine and leucine. C. A. S.

2359. Superficial or Interfacial Orientations Determined by means of X-Rays Tangent to a Drop. J. J. Trillat. *J. de Physique et le Radium,* 10. *pp.* 32–43, Jan., 1929.

The author's method of X-ray spectography has been used to study the state of the surfaces of separation between liquid and liquid, liquid and solid, solid and air, liquid and air. The phenomena of molecular orientation in these surfaces have been made evident. In particular the chemical action between fatty acids and mercury has been studied and the solidification of long chain-organic compounds. Observations have been made of the influence of temperature on substances which fuse to a pasty condition (oleate of soda). The results are similar to those recently described by the author [see Abstract 2093 (1929)]. H. N. A.

2360. Replacement of Water Vapour in the Wilson Cloud Chamber in Atom Shattering Investigations. K. Philipp. *Zeits. f. Physik*, 53. 1–2. *pp.* 100–101, 1929.

In experiments on atom shattering (Atomzertrümmerung), using the Wilson cloud-chamber method, it is often necessary to be sure that no hydrogen atoms are being formed naturally from the water vapour used to produce the cloud. It is desirable to replace the water vapour, therefore, by the vapour of a substance not containing hydrogen. Carbon tetrachloride has been found a highly suitable substitute. One disadvantage, the rather high expansion ratio, can be minimised by using argon in the chamber in place of air, a reduction of 11 % in the ratio being thereby effected. W. S. S.

2361. Energy Transfer between Atomic Systems in Quantum Mechanics. Abnormally Large Effective Atomic Sections. H. Kallmann and F. London. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 207–243, *Feb.*, 1929.

Deals with cases where it is necessary to assume that atoms exchange their excitation energy at distances which are far outside their spheres of action in the kinetic theory of gases, where it seems difficult to suppose that the energy is transferred by radiation, since in the optical sense there is no sharp resonance. It is shown that according to quantum mechanics there is a possibility of a special resonance phenomenon, *quantenmechanische Resonanzersheinung*. For this much stronger alternating fields than those found in the case of ordinary light waves are required; if these are so strong that excitation can take place in a time which is short compared with the mean natural life of the excited atom resonance can take place, even when the period of the atom is out of tune with that of the alternating field by some thousandths of the frequency. Such strong alternating fields may be found near an atomic light source, close to which an atomic resonator may approach. This is the case in sensibilised fluorescence, excited Hg atoms in Na vapour for example. The theory is worked out so as to obtain what is spoken of as the " effective sectional area " of the atom, which can be very much greater than the ordinary sectional area. A number of practical cases are dealt with, and the kinetics of chemical reactions are considered. H. N. A.

2362. Determination of Molecular Weights in the Vapour State from Vapour Pressure and Evaporation Data. E. W. Washburn. *Bureau of Standards, Journ. of Research*, 2. *pp.* 703–713, *April*, 1929.

The molecular weight of a substance in the gaseous state may be found from a measurement of its vapour pressure at some temperature and the mass required to saturate a known volume of an indifferent gas at the same temperature. By employing a reference substance of known molecular weight, the measurement of the volume of aspirated gas is unnecessary, and the quantities measured have small temperature coefficients. A precision discussion of this method is given; the paper contains no experimental results, but is confined to a mathematical discussion of the influence of the various sources of error on the final determination. A. A. D.

2363. Pulsating Electrified Spherical Skins, the Principle of Areas and the Zeeman Effect. L. Décombe. *Comptes Rendus*, 188. *pp.* 865–867, *March* 18, 1929.

1. The azimuthal displacement of an electron under a central force during the time occupied by the light traversing the radius vector is constant (law of areas) and is an integral multiple of $\lambda_0/2\pi$; the area described by the radius vector during a fundamental pulsation of the election is $\lambda_0^2/2\pi$.

2. The secondary beats due to the magnetic field are in resonance with the frequency of precession of the orbital plane. *Errata* (*ibid.*, p. 1726, May 6, 1929). T. M. L.

2364. Electrified Spherical Pellicles and the Stark Effect. L. Décombe. *Comptes Rendus*, 188, *pp.* 1094–1096, *April* 22, 1929.

The author applies his theory of the electron as a pulsating spherical pellicle to the Stark effect, tracing connections between the variations in the frequency of these pulsations and the frequency of the variations of the azimuthal and parabolic parameters. The Stark effect is explained as due to the action of the electric field on the pulsations, and is measured by the difference in the variations caused thereby in the pulsations of the electron in the two levels between which it moves. He also points out that there is no substantial difference between his results and those of Sevin. [See Abstracts 715, 2505 and 2506 (1929).] C. A. S.

2365. Schrödinger's Equation and Energetics. A. Proca. *J. de Physique et le Radium*, 10. *pp.* 1–14, *Jan.*, 1929.

The author develops an analogy between mechanics of a conservative system and thermodynamics. It appears that the suitable magnitude to choose corresponding to the entropy function is the action function. Then, following Boltzmann, the classical action function is set equal to $k \log \psi$, where ψ is the probability of the system being in a given state, and k is a constant chosen to equal $h/2\pi i$. By inserting this value ($k \log \psi$) into Jacobi's equation for the action function, an equation for ψ is obtained, which, *provided a certain further condition is satisfied*, reduces to Schrödinger's equation. The author is of opinion that although for intra-atomic movements this further condition is satisfied, yet in general it is not true, so that not all movements necessarily take place in accordance with the de Broglie-Schrödinger phase waves. W. S. S.

2366. Theory of Quantum Jumps. J. Ullmo. *J. de Physique et le Radium*, 10. *pp.* 15–31, *Jan.*, 1929.

Classical mechanics does not take into account the fact that the forces of interaction which affect an electron are propagated by waves. The author attributes the discontinuity manifested in the quantum theories to a fundamental property of matter, which, according to his theory, can only emit or receive exterior actions at Hamiltonian action intervals equal to h. This makes it possible to define frequencies for the surrounding field of force acting on an electron. This surrounding field thus appears to be discontinuous, since " exploring electrons " are required to make its existence evident, and these only interact with it at the above Hamiltonian action intervals h; between these instants the field is to be regarded as practically non-existent. For this discontinuous field a fictitious continuous field of the same amplitude and frequency is substituted when it is studied mathematically. Only certain of the above frequencies are stable, and make possible stable equilibrium between the field and the electron; these are the frequencies given by Schrödinger's equation, which can be derived from the above considerations; it is a new equation of condition, added to the equations of classical mechanics. An interpretation of the fifth dimension is proposed, the *action*, and the reason for the simplification which this produces in the calculations, is given. The relations to the theories of Weyl and of Dirac are considered. H. N. A.

2367. Dirac's Equation. D. Iwanenko. *Comptes Rendus*, 188. *pp.* 616–618, *Feb.* 25, 1929.

The object of the paper is to help to elucidate the physical meaning of the matrices γ_i of Dirac's equation, and to suggest a geometrical interpretation of the corresponding equation of the second order. H. N. A.

2368. Propagation of Waves in Selectively Absorbent Media. G. Giorgi. *Accad. Lincei, Atti*, 9. *pp.* 8–11, *Jan.* 6, 1929.

Mathematical. Shows how a calculation depending on matrices of infinite order may be carried out with finite matrices combined with normal functional operators. A. D.

2369. Functional Operators and the Calculus of Infinite Matrices in Quantics. L. Fantappiè. *Accad. Lincei, Atti*, 9. *pp.* 197–202, *Feb.* 3, 1929.

Mathematical. Sequel to a former paper [see Abstract 1451 (1929)]. Leads to simplified expressions. A. D.

2370. Eigen Value Theory. V. Ambarzumian. *Zeits. f. Physik*, 53. 9–10. *pp.* 690–695, 1929.

The method of Schrödinger's wave theory is to deduce the eigen value spectrum from the wave equation based on the Hamiltonian of the system. The present author inquires as to the possibility of deducing from the eigen value spectrum, the corresponding wave equation. This corresponds to the problem of deducing the structure of an atomic system from its optical spectrum. For a certain special case (vibrating string, natural boundary conditions) it is shown that the eigen value spectrum determines uniquely the generating differential equation. W. S. S.

2371. Tensorial Form of the Wave-Mechanic Equations of the Electron. H. Mandel. *Zeits. f. Physik*, 54. 7–8. *pp.* 567–570, 1929.

The author proposes a five-dimensional form of the Dirac equations [see Abstract 247 (1929)] and discusses a possible geometrical interpretation of the probability field ψ^{ik}. H. H. Ho.

2372. Wave Equation in Five Dimensions. J. W. Fisher. *Roy. Soc., Proc.* 123. *pp.* 489–493, *April* 6, 1929.

It is shown that there is a striking analogy between the equation for radiation in ordinary space time and the wave equation for a single particle in the 5-space. The possibility of this analogy being the basis of a method of expressing the quantum behaviour of several electrons, including the "spin," is suggested. C. A. S.

2373. Vectorial Fields. R. Ferrier. *R.G.E.* 25. *pp.* 597–606, *April* 20, 1929.

The author develops the elements of vectorial and tensorial calculus. J. S. G. T.

2374. Repetition of the Michelson-Morley Experiment. A. A. Michelson, F. G. Pease and F. Pearson. *J.O.S.A. and R.S.I.* 18. *pp.* 181–182, *March*, 1929.

Two preliminary and one final series of experiments, in repetition of the Michelson-Morley ether-drift experiment, yielded negative results. In the final series, carried out at Mount Wilson Laboratory, the length of the light path was increased to 85 feet and effective precautions were taken to eliminate possible temperature and pressure disturbances. The results gave no displacement as great as 1/50 of that to be expected on the supposition of an effect due to a motion of the solar system equal to 300 km. per sec. J. S. G. T.

2375. Unified Field Theory. A. Einstein. *Preuss. Akad. Wiss. Berlin, Ber.* 1–2. *pp.* 2–7, 1929.

The difficulty and possibly equivocal character of the deduction of the field equations of the unified field theory by Hamiltonian methods [see Abstract 69 (1929)] are removed by an entirely new method of deduction of the equations. The divergence of the tensorial density is shown to vanish identically, thus $(V^{a}_{kl})_{/a} \equiv 0$. The assumption is made that the divergence of the associated pure contravariant tensor $(V^{a}_{kl})_{/l}$ also vanishes. The equations of the gravitational field *in vacuo* follow as a first approximation. The equations of the unified theory are embraced on the relation $\overline{V}^{a}_{kl/l} = 0$, where $-a\,\overline{V}^{a}_{kl} = V^{a}_{kl} - \epsilon h(\phi_l \delta^a_k - \phi_k \delta^a_l)$, the symbols having their customary significance and are deduced in the form $G^{ka} = 0$, $(1/\epsilon)\overline{G}^{kl}_{/l} = 0$. J. S. G. T.

2376. Simplified Deduction of the Field Equations of Einstein's Unified Theory. T. Levi-Civita. *Preuss. Akad. Wiss. Berlin, Ber.* 8–10. *pp.* 137–153, 1929.

A simplified and more general deduction of the equations of Einstein's unified field theory, employing only the familiar principles of absolute calculus and retaining well-established results in the theory of relativity, but avoiding the introduction of covariant derivatives as employed by Einstein, is given. [See preceding Abstract.] J. S. G. T.

2377. Unified Theory and Hamilton's Principle. A. Einstein. *Preuss. Akad. Wiss. Berlin, Ber.* 8–10. *pp.* 156–159, 1929.

In a previous paper [see Abstract 2375 (1929)] the field equations of the unified theory were deduced without recourse to Hamilton's principle. Lanczos and Muntz have questioned the validity of this method and its results, more especially as the four identities satisfied by the sixteen field equations were not established. A perfectly satisfactory of the problem, based upon the Hamilton principle, is now given. J. S. G. T.

2378. Einstein's Field-Theory. A. S. Eddington. *Nature*, 123. *pp.* 280–281, *Feb.* 23, 1929.

The author presents a slightly modified and shortened version of Einstein's unified field theory [see Abstracts 69 and 2375 (1929)] and contrasts it with the affine field theory developed in 1921.

J. S. G. T.

2379. New Field Theory. A. Einstein. *Observatory*, 52. *pp.* 82–87, *March*, *and* 114–118, *April*, 1929.

The author gives an explanation of his thesis for readers who do not possess an expert knowledge of mathematics. The first article is an historical sketch of the development of field theory from Newton up to the introduction of the relativity theory. The second article describes, in the most general terms of which the subject permits, the mathematics necessary to the development of the general relativity theory and the new unified field theory. This latter theory is based on the discovery that there are continua with a Riemannian metric *and* distant parallelism but which, nevertheless, are not Euclidean. J. S. G. T.

2380. Synthetic Theory of Gravitational and Electrical Fields. T. de Donder. *R.G.E.* 25. *pp.* 644–648, April 27, 1929.

A translation of Einstein's recent paper on unified field theory [see Abstract 2375 (1929)] is prefaced by remarks by the author briefly summarising the essential mathematics of the older theory and pointing out the *doubly* covariant character of Einstein's sixteen fundamental equations.

J. S. G. T.

2381. Basic Principles of Einstein's Special Theory of Relativity. G. Hueber. *Zeits. f. Physik,* 54. 11–12. *p.* 880, 1929.

The author shows that equations employed by Broszko [see Abstract 1791 (1929)] are really equivalent to the two fundamental postulates of Einstein's special theory. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

2382 Construction and Use of Minimum Temperature Formulæ. E. S. Ellison. *Monthly Weather Rev.* 56. *pp.* 485–495, *Dec.,* 1928.

After a consideration of the factors influencing the minimum temperature, the relative merits of different systems and the limitations in the construction and application of minimum temperature formulæ in actual forecasting practice are examined. Formulæ involving temperature or humidity only are unsatisfactory and the best is the Young formula, $y = d - (h - n)/4 + V_d + V_h$, where y is the minimum temperature obtained, d the dew point and h the relative humidity at the evening observation, n a number deduced from statistics and V_d and V_h variables dependent on d and h respectively. This must be based on ten-year observations. Until ten-year observations are available a Smith or Nicols type of formula is best, as these lend themselves to interpolation. The formulæ are not satisfactory for elevated stations because of the errors introduced by temperature inversions, while the forecast or key station must be placed as nearly as possible to the point where the cold air draining from the surrounding slopes first gathers to form the nucleus of the pool of cold air that covers the lower land in the morning.

R. S. R.

2383. Three-Dimensional Thermo-Isopleth. G. H. Smith. *Science,* 69. *pp.* 404–405, *April* 12, 1929.

For ease in conception by students the author constructed for Mexico City a thermo-isopleth in which the horizontal coordinates represent (1) the months of the year and (2) hours of the day. At each intersection of these an ordinate is set up whose height is proportional to the corresponding mean hourly temperature. The isotherms, when drawn over the resulting surface provided by these points, give a better representation of the facts to be demonstrated. R. S. R.

2384. Measurements of Ozone in the Upper Atmosphere during 1928. H. Buisson. *Comptes Rendus,* 188. *pp.* 647–648, *Feb.* 25, 1929.

The author has tabulated the daily measurements of ozone during the year at Marseilles and found for the year a maximum thickness of 3·75 mm. in spring and 2·25 mm. in autumn. The results are in good agreement with those obtained by a different technique at Arosa (1800 m.), and both confirm that the mean thickness of the ozone layer in 1928 was less than that in 1927 by 0·16 mm. R. S. R.

2385. Diro Kitao's Work on Aerial Dynamics. B. Haurwitz. *Gerlands Beitr. z. Geophys.* 21. *pp.* 81–102, 1929.

In 1887, 1889 and 1895, Diro Kitao, of Tokyo, put forward a theory of aerial dynamics which appears to have been completely forgotten. Following the ideas of Diro Kitao, the author has developed the equations vector-analytically, whereby the formulæ become essentially simpler. After the introduction of an orthogonal system of coordinates, the equations of motion of the " centres of mass " of two atmospheric eddies are derived; only for $n = 2$ can the problem be reduced to quadratures. The integration of the differential equations leads to some results which recall well-known theorems of analytical mechanics. Under certain suppositions it follows that two cyclones with constantly decreasing distance and increasing radial velocity rotate round their common centre of mass counter-clockwise. Two anticyclones, however, increase their distance, rotating round their common centre of mass clockwise. A. D.

2386. Ellipticity of the Earth's Equator. M. Bossolasco. *Comptes Rendus,* 188. *pp.* 694–696, *March* 4, 1929.

A reply to criticisms by T. Banachiewicz of results obtained by the author in a former paper is first given. A demonstration is next given of a simpler and more direct method of obtaining the distribution of gravity of the geoid, employing the empirical formulæ of Berroth, Helmert and Heiskanen. This leads to results in good agreement with those obtained by W. Bowie and giving a difference in the axial lengths smaller than that obtained by Heiskanen. R. S. R.

2387. Dune Studies on the Kurische Nehrung, with an Appendix on Meandering Flow, Wave-Form Clouds and Cyclones Produced by Frictional Vortices. F. M. Exner. *Akad. Wiss. Wien, Ber.* 137. 2*a. Nos.* 9–10. *pp.* 705–739, 1928.

The author gives the results obtained from a series of measurements on the sand-dunes of the variation of sand density in air at different heights and with different wind strengths. The lifting of the sand by vertical air movement was next considered for fine and large grains, the latter predominating behind the crest in the lowest part of the trough where the wind is lightest. A series of photographs of different types of waves accompanies the paper, and the formation of these is explained. Finally, the formation of sand-waves which originate from vortex movement is described for linear and rotational movement of the liquid and the results applied to some numerical examples. In the Appendix this general treatment is applied to vortices formed in the air and in water. R. S. R.

2388. Indirect Induction of Elastic Plane Waves at the Boundary of Two Solid, Isotropic, Weightless and Static Media. K. Uller. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 313–343, 1929.

This very comprehensive mathematical publication deals with the subject under the following subsections: incidence of a rarefied plane wave upon a plane-free surface; the same for a shear-plane wave; incidence of the two kinds of wave upon the separation plane of two bodies; certain limiting cases; indirect induction of a surface wave pair by the two kinds of wave; indirect induction of a double media wave pair. The paper should be consulted in its entirety. H. H. Ho.

2389. Rayleigh Waves having Some Azimuthal Distribution. K. Sezawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 1–18, *March*, 1929. *In English.*

Continues the work described in a previous paper. Waves due to a source in the interior of a semi-infinite body, bounded by a plane surface, are here discussed, and propagation on the surface of a spherical body. In a plane surface the azimuthal component of displacement quickly disappears as the distance from the origin increases; this behaviour is quite different from that of the bodily elastic waves. At the equatorial circle of the sphere, long Rayleigh waves have azimuthal and ordinary components of comparable magnitudes; near the seismic pole these waves have an azimuthal component which is large compared with the vertical and radial components. Short waves have a large azimuthal component only in the immediate vicinity of the seismic epicentre. H. N. A.

2390. Deep Water Waves Due to Subaqueous Shocks. K. Sezawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 19–46 *March*, 1929. *In English.*

Six cases are dealt with mathematically—disturbances due to a symmetrical shock, and to doublets oscillating horizontally and vertically, all in two and in three dimensions. Equations for the resultant disturbances on the surface are worked out. These are shown to be chiefly ordinary gravity waves of the same period as that of the origin, but of relatively large amplitude as compared with that of the original displacement. The orbital motion of a water particle is always circular. The three-dimensional case of a horizontally oscillating doublet is exceptional in that here the azimuthal component of displacement quickly disappears as distance from the origin increases. C. A. S.

2391. Mechanism of Production of Seismic Waves. M. Ishimoto. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 127–147, *March*, 1929.

The results of levelling after an earthquake show that there are blocks of land each moving as a whole but independently of adjacent blocks, whence it is concluded that there is a plastic layer below these blocks on which they may be regarded as floating. This view is supported by the effect of atmospheric pressure changes in precipitating earthquakes. Seismic waves are due to the shock caused by the sudden stoppage of a moving mass of plastic magma when the fissure into which it flows is full. After-shocks are caused by the entry of magma into fissures produced by the main earthquake, while topographical changes result from the reestablishment of isostatic equilibrium. Seismic waves decrease when crossing a fault. C. A. S.

2392. Position of Hypocentre of an Earthquake and Velocity of Propagation of Seismic Waves. R. Takahashi. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 231–244, *March,* 1929. *In English.*

The position of the hypocentre is deduced from the duration of preliminary tremors at four stations so situated that the epicentre falls within the quadrilateral so defined. It is assumed that the velocity of propagation of seismic waves is independent of depth, and shown that this may be done provided the epicentral distance is small compared with the depth of the focus. The method is applied to determining the hypocentres of the aftershocks of the Great Tango earthquake and a map showing their distribution relative to faults is given. C. A. S.

2393. Periodicity of Earthquakes. T. Terada and N. Miyabe. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 333–343, *March,* 1929. *In English.*

An endeavour is made to show a connection between the latitude of the places (grouped according to the chief divisions of the globe) where severe earthquakes have been specially frequent and the time of occurrence. It is thought that a period of about 200 years may be traced. C. A. S.

2394. Elastic Equilibrium of a Spherical Body under Surface Tractions. K. Sezawa and G. Nishimura. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 47–62, *March,* 1929. *In English.*

The paper deals with the elastic equilibrium of a non-gravitating spherical solid whose elasticities and density are uniform. In the first section the general solutions of the problem have been obtained in the form of harmonic functions, while the second section deals with polar loads with certain zonal and azimuthal distributions. It is found that (1) however sharp the concentrated stress on the surface of the sphere may be, the interior stresses tend to a uniform distribution; (2) even though only the radial stress (excepting zero tangential stress) is specified, the azimuthal and colatitudinal components of the stress are of comparable magnitude with the radial component, a fact having some importance on the breakdown problem of the earth crust. The lack of homogeneity of the earth with increase of depth involves corrections to the results obtained. R. S. R.

2395. Tilting Motion of the Earth's Crust Caused by Tidal Loading. R. Takahashi. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 85–108, *March,* 1929. *In English.*

From observations taken at Misaki, on the Miura Peninsula, with a tiltmeter, details of which are given, the author concludes that the tilting of the earth's crust near a sea-shore follows faithfully the ebb and flow of the ocean tides. The tilting observed, 22 in. at 23 m. from the beach line, by a tide of 34 cm., is almost wholly explained by tidal loading, other possible causes producing only about 1 in. The secondary undulations of tides or seiches produce a sensible tilting. No former solution quite holds good in this case, and it is assumed that the rigidity of the crust effective in producing tilting is a function of the distance between the load and the station and of the period of variation of the load. The curve obtained shows a sudden jump in the value of effective rigidity at a distance of 150 m. from the observing station. Possible explanations are examined. Further observations at this and other stations are to be undertaken. R. S. R.

2396. Deformation of Sand Mass by Lateral Pressure. T. Terada and N. Miyabe. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 109–126, *March*, 1929. *In English.*

The results of further experiment on fine and coarse sand particles which are subjected to pressure due to (1) a wall moving with nearly uniform small velocity, and (2) a reciprocating movement of the wall, are described, and successive photographs show the slip planes which result. The formation of these slip planes is discussed. The author states that the difference between fine sand closely packed and coarse sand loosely packed is somewhat similar to that between a brittle material and a plastic one, so far as the geometrical, and perhaps also the kinematical, relation of deformation is concerned. The results obtained are applied to some geological and geophysical phenomena to provide explanations of groups of parallel fault lines and progressive upheavals or depressions of the earth's crust. R. S. R.

2397. Earthquakes and their Time-Distance Curves. Parts II, III and IV. T. Matuzawa. *Tokyo Univ. Earthquake Research Inst., Bull.* 6. *pp.* 177–229, *March*, 1924. *In English.*

In an earlier paper [see Abstract 77 (1929)] dilatational waves only were considered. In the present paper the distortional waves are examined, the existence of S, $\bar{S}$ and $\dot{S}$ movements confirmed and the corresponding time-distance curves found. The differences in appearance depend on depth of seismic origin, epicentral distance and mechanism of seismic occurrence, while superficial crustal stratification is proved even for such an unstable area as Japan. A mathematical examination of the curves indicates a sudden change of velocity about 70 km. from the lower discontinuity, *i.e.*, 120 km. below the earth's surface, a value in agreement with that obtained by Helmert and Hayford. Confirmation is obtained of the existence of Love and Rayleigh waves, the former having a longer period but being less coherent and regular. They are more definite for transpacific than for transcontinental waves. Finally, dispersion of Love waves is shown for transpacific and transcontinental waves, but the modes of dispersion differ. R. S. R.

ASTROPHYSICS.

2398. Astronomical Refraction in Rome. G. Armellini. *Accad. Lincei, Atti*, 9. *pp.* 30–34, *Jan.* 6, 1929.

The constant of refraction has been assigned different values. In Radau's tables it is 60″·4455; in the *Connaissance des Temps* the Paris Observatory has changed over to 60″·154; the Abbadia Observatory has adopted 60″·615. It looks as if the constant must have different values at different places. The author has made a fresh determination of it for Rome, and finds 60″·51. A. D.

2399. Constitution of the Solar Atmosphere and Identification of Boron in Sun Spots. S. B. Nicholson and N. G. Perrakis. *J. de Physique et le Radium*, 10. *pp.* 49–51, *Feb.*, 1929.

In the case of the lighter elements, those which have not yet been observed in the sun occur in general in the extremities of the periods of the Mendéleef table, which are occupied usually by elements of high ionisation potential. Exceptions to this rule are helium with a high ionisation potential which is present, and boron with a low ionisation potential which has not previously been observed. A brief résumé is given of researches at Mount Wilson Observatory which have enabled boron to be definitely identified in the spectra of sun spots. [See Abstract 1089 (1929).]

W. S. S.

2400. Solar Streams of Corpuscles. S. Chapman. *Roy. Astron. Soc., M.N.* 89. *pp.* 456–470, *March*, 1929.

The author deals first with the motion of a stream of corpuscles emitted from a point on the sun and calculates the time taken and the hour at which this stream will reach the earth. The case is then extended to emission from other parts of the sun. The lateral expansion of the stream is considered and the means of associating these streams with terrestial magnetic disturbances. It is pointed out that there is a possibility of determining the density and velocity of such a stream by observations of the line—absorption which it will produce in the spectrum of light from undisturbed regions of the sun, when these are viewed from the earth while the latter is enveloped in a stream, as is supposed to be the case during magnetic storms. Finally, the difficulty in accounting for the penetration of the corpuscles into the earth's atmosphere to the lowest observed auroral levels is discussed. R. S. R.

2401. Electrical State of Solar Streams of Corpuscles. S. Chapman and V. C. A. Ferraro. *Roy. Astron. Soc., M.N.* 89. *pp.* 470–479, *March*, 1929.

The authors assume the process of emission given by E. A. Milne [see Abstract 2306 (1926)] to exist. Initially the cloud is supposed to have a positive head and a negative tail as a result of radiation pressure, but this state is lost quite near the sun. The cloud is left with a slight positive charge, and it adjusts itself such that a slow leakage of electrons is balanced by expansion of the cloud. The charge is almost wholly confined to a surface shell and the interior is practically neutral. Numerical illustrations are given of the formulæ developed in the paper. The ratio of charge to mass in the cloud is finally considered in its application to the terrestrial problems of magnetic storms and auroral displays. R. S. R.

2402. Astronomical Consequences of the Polarisation of Fluorescence. Y. Öhman. *Roy. Astron. Soc., M.N.* 89. *pp.* 479–482, *March*, 1929.

From consideration of results already obtained on the polarisation of fluorescence, the author concludes that this phenomenon should be observed in the bright line spectra of the chromosphere and prominences, especially for the Balmer lines and the H and K lines of ionised Ca. Although Meyer detected no polarisation effects for planetary nebulæ, probably because the lines were not due to resonance, the author considers the effect may be found there too. R. S. R.

2403. Hydrogen Chromosphere. W. H. McCrea. *Roy. Astron. Soc., M.N.*, 89. *pp.* 483–497, *March*, 1929.

Pannekoek and Minnaert have measured the absolute intensity of the Hγ hydrogen line in the "flash" spectrum, and from their results the author derives the number of atoms in a column (whose base is distant $y(=a\eta)$ from the limb) as $\sqrt{2\pi(1127)^{-1}}\,n_0 a \exp(-1127\eta)$. He has also shown [see Abstract 84 (1929)] that the distribution of atoms among the stationary states initiates thermodynamic equilibrium at temperature T′ (say), and finds that the number of atoms per cm.^{3} in the Balmer state $(l = 1)$ as $(n_1)_0 = \frac{1}{25}(n_5)_0 \exp\left(h\nu\cdot{}_5\frac{1}{k}\cdot T'\right) = 1\cdot 03 \times 10^{12}$, which is high as compared with Milne's value for Ca^+ ions as 10^6 (approx.), but is corroberated by observations of the continuous spectrum at the head of the Balmer series [see Abstracts 2231 (1927) and 2305 (1928)]. Miss Payne [Abstract 2645 (1928)] and Unsöld [Abstract 1200 (1928)] also indicate predominance of hydrogen over calcium in the outer layers of the sun. The author analyses the scattering of light by the free electrons of the ionised gas and finds the value $3\cdot 7 \times 10^{-5} I_0$ for the base of the corona as of the right order of magnitude, and suggests that the continuous light of the corona is scattered by electrons produced by the chromospheric hydrogen; and seeing that an unexpected quantity of ions and electrons in the chromosphere gives the right order of observed continuous intensity, he anticipates that the outer corona is directly connected with these ions and electrons. The scattering radiation-pressure (2×10^{-24} dynes per electron) is small compared with gravity. The excess of ionised hydrogen prevents Ca^+ from becoming Ca^{++}. Neither gas pressure nor gravitational equilibrium can support even a fraction of the isothermal hydrogen atmosphere, and he suggests the action of electrical forces. A. S. D. M.

2404. Structure of Solar Chromosphere. L. d'Azambuja. *Comptes Rendus*, 188. *pp.* 773–775, *March* 11, 1929.

An investigation whether the granulation characteristic of the structure of H_1, K, of ionised calcium [see Abstract 287 (1928)] is identical with that of other vapours. The author describes the modifications of the Meudon spectroheliograph needed for this study, and notes that the observations must be made at such rare moment as when the atmosphere is completely calm. They must also be confined to that part of the spectrum for which the spectroheliograph is perfectly achromatic, limiting the investigation in fact to the two pairs, Ca4227-Fe4384 and Ca4227-Fe4202, the line 4202 being on a lower level than the reversing layer. When examined with the Blink microscope the various simultaneous images showed no sensible differences in either form or distribution of the grains. This seems to indicate that the structure is identical in the lower calcium and iron vapours, and for the latter element that the difference of level has no sensible influence on the granulation; on the other hand this may be due to insufficient difference in the level. The high-level line H_α of hydrogen seems to show that in undisturbed regions of the disc there is great resemblance to lower granulation; as elsewhere, it gives maximum visibility when the slit is placed at the border of the line. A. S. D. M.

2405. Selenographical Tables. T. Banachiewicz. *Acad. Polonaise Sci. et Lettres, Bull.* 1*a. pp.* 1–22, *Jan.*, 1929. *In French.*

These tables are designed to facilitate the conversion of differential equatorial coordinates observed on the moon's surface into selenographical coordinates, especially when irregularities of the moon's limb must be taken into consideration in calculating occultations and eclipses. The methods of constructing and of using the tables are explained. It is assumed that the new Cracovian kind of formulæ will be used, and a brief exposition of these is given, showing how they lessen the labour of calculation. M. A. E.

2406. Identification of Small Planets and Correction of their Orbits from an Observation. B. Jekhowsky. *Comptes Rendus*, 188. *pp.* 1035–1037, *April* 15, 1929.

The author provides a mathematical solution which is claimed to be without ambiguity and permits the identification of a planet. The factors of correction are found and expressed in an equation, and the system of elements is thus corrected. R. S. R.

2407. Limit of Visibility with Small Refractors. G. B. Lacchini. *Accad. Lincei, Atti*, 9. *pp.* 304–309, *Feb.* 17, 1929.

Explains how the eye may be trained, by focussing upon infinity and consequent widening of the pupil, to perceive fainter stars than are seen by the untrained eye. A. D.

2408. "Autocomparator." W. H. Christie. *Roy. Astron. Soc. Canada, J.* 23. *pp.* 90–92, *Feb.*, 1929.

A short description, with figures, of a measuring instrument, which is based on the Hartmann spectro-comparator, but instead of measuring the distance between a line in the standard comparison spectrum and a corresponding line in the star spectrum under observation, the optical train is so arranged that two distinct images of the same line are measured against one another. This should be of great advantage in measuring broad diffuse lines, and unsymmetrical lines, and moreover the accuracy of measurement is increased by the fact that the observed displacement is double the actual. M. A. E.

2409. Calculating Machines for Finding the Paths of Comets and Minor Planets from Short Arcs. R. T. A. Innes. *Roy. Astron. Soc., M.N.* 89. *pp.* 422–450, *March*, 1929.

The formulæ at present in general use, the author states, are not convenient for working with electric or hand-driven calculating machines. In the method detailed by the author no assumption is made regarding the form of the path, but the sum is assumed to be the only attracting body. The attractions due to the planets can be included. Equatorial rectangular coordinates are used throughout, and four illustrations of the method are given, one for a minor planet and three for comets. R. S. R.

2410. Cometary Spectra. F. S. Hogg. *Roy. Astron. Soc. Canada, J.* 23. *pp.* 55–89, *Feb.*, 1929.

Since Donati made the first spectroscopic observation of a comet in 1864 many others have been made, but they give contradictory results as to physical composition and behaviour, often because of large inherent differences between the comets. It was resolved therefore to find the average spectrum of a comet's head, and to determine its dependence on the heliocentric distance. 830 spectroscopic observations of 94 comets, which were published in 410 papers between the years 1864 and 1927, are here discussed and summarised, and the wave-lengths, intensities, occurrence and identifications of the emission lines and band heads are tabulated. Only nine lines remain unidentified; these all lie in the visual region and appear only when the comet is very near the sun. The relation between the heliocentric distance and the mean intensity of the prominent bands and lines has been found. The Swan, cyanogen and Raffety bands reach their maxima at from one to two units distance from the sun, but the D lines of sodium are evidently at maximum at the sun, and are absent beyond eight-tenths of a unit. A comparison between the spectra of comets and of meteoric elements shows that the identified lines (Na, Fe, Ni and Cr) are those which would be expected if cometary heads are composed of meteoric stones. Interpretation of the observed curves suggests that the atmosphere of a comet is not in effusive equilibrium, and that the effective partial pressure is of the order of 10^{-14} atmospheres when the comet is one-tenth of a unit from the sun, decreasing to 10^{-16} atmospheres when at one unit distance. Methods of spectrophotometrical observation of future comets are suggested. The chief aim should be to obtain a curve giving the absolute energy as a function of wave-length, over as long a range of spectrum as possible; a series of such curves for a number of comets, over a large range of heliocentric distance, would settle many questions. M. A. E.

2411. Engineering Principles in the Machinery of the Stars. A. S. Eddington. *Inst. Mech. Eng., Proc. No.* 1. *pp.* 43–63, 1929.

The closest relation between astronomy and engineering is in the problem of the construction of telescopes, and the 200-inch reflector now planned at Mount Wilson, which requires the utmost skill of the engineer to design and mount, will be a momentous addition to the means of astronomical research. But it is also true that astronomers are investigating the great power stations of the universe. The lecturer showed how the laws of mechanics and of thermodynamics are applied to the stars; he spoke of studies in stellar structure under conditions of pressure, heat and density unknown on earth; of strange properties of matter under high ionisation; of the output of heat; of the possibility of gas in a crystalline state; of the pulsating stars (Cepheids); and of the problem of fuel supply. It now seems probable that stellar energy is supplied by destruction of matter within the stars, so that stars are becoming always less massive and less bright, but there are observational results difficult to reconcile with this. The problem is, however, growing clearer, and will advance by many and varied lines of research; and a future astronomer speaking to engineers may be able to explain more about the stores of energy which are held so fast and so tantalisingly within the atom. M. A. E.

2412. Meteoric Matter near Stars. H. N. Russell. *Astrophys. J.* 69. *pp.* 49–71, *Jan.*, 1929.

Under the most favourable circumstances no meteor under a foot in diameter will escape volatilisation before reaching the sun's surface, and all meteorites of the same composition at the same distance from the sun will diminish in diameter at the same rate. The evaporation of meteors is particularly effective near the hotter stars. Unless held back by radiation pressure the gaseous debris will keep on with parabolic velocity as a shower of swiftly moving atoms; violent atomic collisions occur and much energy passes into ionisation and excitation of the chromosphere. Some of the gas may scatter the star's radiation, both by ordinary, non-selective scattering and by resonance. The author points out the difference as perceived by a near and by a distant observer of the star. Some radiation is scattered back into the star, increasing very slightly its general radiation, and, if selectively re-radiated, tends to fill up shallow dark bands. It sets an upper limit to the amount of radiant energy in c.g.s. units per sq. cm. of the star's surface which can appear as depletion of the spectrum, and he makes numerical applications showing that meteoric matter cannot exert enough effective absorption in the spectrum to produce the equivalent of a single narrow Fraunhofer line. Supposing that 10^9 meteors strike the earth every day, he finds that the average mass of a meteor cannot exceed 2 mgm. and that the whole meteoric infall on the sun is at most 60 tons per second. For stars, results are similar, and perceptible bands in the spectrum can only, and that doubtfully, be accounted for by immersion of the star in very dense nebulosity. [See Abstract 438 (1929).] A. S. D. M.

2413. Asteroidal Band. A. Auric. *Comptes Rendus*, 188. *pp.* 490–491, *Feb.* 11, 1929.

The asteroids tend to aggregate at 2·75 and at 3·15 a.u. from the sun, and show a minimum at 2·95, indicating that they form two families differing in origin and constitution, and this is borne out by their orbital eccentricities and inclinations. Their speed of revolution round the sun varies from 14·5 to 21·3 km., being of the same order as the solar motion toward the apex, and this may be the critical velocity in formation of planets. The author, therefore, investigates if this might hold good also for satellites, and he calculates to this end the resultant velocity for each planet of its speed round the sun with the velocity of translation of the solar system, and compares it with that of a satellite grazing its primary's surface. He gives tables of these values, and finds for Saturn an almost complete coincidence with the ring's velocity. He finds nothing to forbid the existence of a ring round Jupiter between Barnard's satellite and Io, but rings are not possible in any other planetary system.

A. S. D. M.

2414. Correction of Asteroidal Ephemerides. B. Jekhowsky. *Comptes Rendus*, 188. *pp.* 548–550, *Feb.* 18, 1929.

After an observation the usual procedures for this are by the methods of Fabry, Popovici or Michkowitch, but none of these represents the observation exactly. The author proposes to correct the true anomaly (ν) and heliocentric distance of the planet (r), and not the mean anomaly (M) and angle of eccentricity (ϕ), thus both representing the observation exactly and ensuring (by taking account of r) that previous calculations are utilised. With the usual notation he obtains the equations: $d\nu = \rho\frac{|f_1, \mu_1, \lambda_1|}{|f_1, g_1, \lambda_1|}$, $dr = \rho\frac{|g_1, \lambda_1, \mu_1|}{|f_1, g_1, \lambda_1|}$, $d\rho = -\rho\frac{|f_1, g_1, \mu_1|}{|f_1, g_1, \lambda_1|}$, where ρ is the geocentric distance. By neglecting the variations of dr, as Michkowitch does, he has the simpler equation $d\nu = \rho(\mu_1\lambda_1 - \mu_2\lambda_1)(g_1\lambda_2 - g_2\lambda_1)^{-1}$, and the well-known formulæ of Andoyer give the corrections to dM and $d\phi$. He checks his results by applying them to Tombecka (1013) and Davidweilla (1037). A. S. D. M.

2415. Computation of Orientation of Great Circle of Asteroid Search. B. Jekhowsky. *Comptes Rendus*, 188. *pp.* 771–773, March 11, 1929.

The equations of the author's previous note [see preceding Abstract] permit of a simple determination of the quantity $j = d\delta/d\alpha$ (the variation in declination corresponding to a correction of one minute in right ascension, by which j can be found by means of a single geocentric position of the minor planet instead of three positions as in previous investigations. Replacing in the fundamental equations, μ_1, μ_2 μ_3, by their values as functions of $d\alpha$ and $d\delta$, he obtains in minutes of arc the formula required, $j = d\delta/d\alpha = (15g_3 \cos\delta)(\lambda_1 g_2 - \lambda_2 g_1)^{-1}$. He applies this to (162) Laurentia and (310) Marguerite and gets satisfactory results. A. S. D. M.

2416. Parallactic Motion from the Preliminary General Catalogue of Boss. R. H. Tucker. Astron. J. 39. No. 919. pp. 73–79, *April* 6, 1929

2417. Stellar Parallaxes determined Photographically at Cape Observatory. (First List.) H. S. Jones and J. W. Jackson. *Roy. Astron. Soc., M.N.* 89. *pp.* 497–505, *March*, 1929.

A table is given of 101 stars of proper motions exceeding 30″ per century and south of Dec. − 10°. The authors describe the equipment; comparison stars are in the mean of the 11th magnitude; under good conditions exposure time is 2½ minutes. The measurement of plates is made according to the methods adopted at Greenwich, and these are described. The periodic errors of the Repsold micrometer screw are found to be negligible. The measures are reduced by Schlesinger's method of dependences. The measures are weighted. The observations of each star extend over at least five epochs. The average probable error of a plate of unit weight is ± 0″·025. A. S. D. M.

2418. Alignment Chart connecting Position Angle, Distance of the Apex of the Sun's Way, and Galactic Coordinates with Equatorial Coordinates. J. M. Baldwin. *Roy. Astron. Soc., M.N.* 89. *pp.* 453–456, *March*, 1929.

Particulars are given of the method by which graphs, contained in the publications of the Dominion Astrophysical Observatory, connecting the first three of these quantities may be extended to apply to equatorial coordinates. R. S. R.

2419. Probable Errors of Some Stellar Radial Velocities. W. W. Campbell. *Roy. Astron. Soc., M.N.* 89. *pp.* 506–518, *March*, 1929.

The author criticises a minor conclusion in a paper by H. S. Jones [see Abstract 2968 (1928)] to the effect that the probable error of a Lick observation (of unit weight) of α-Orionis or of α-Scorpii is decidedly larger than a Cape observation. The author argues that Jones' method is theoretically and practically correct when dealing with a star whose radial velocities are varying in great accord with the law of elliptic orbital motion, but not for such stars as α Orionis and α Scorpii, whose observed radial velocities vary in an unknown and irregular way. These irregular fluctuations occur now and then within a period of a month, so that Jones' method cannot be safely used for intervals between observations greater than a very few days. But the Lick intervals he used were in many cases long: 6, 7 or 8 weeks, 2⅔ months, 4½ months, 11 months. The average time interval for the 87 Cape pairs (for α Scorpii) is 7·1 days; for the 32 Lick pairs is 36·4 days. The author also criticises H. S. Jones' paper on four spectroscopic binaries [see Abstract 2960 (1928)], where there are systematic differences between the Cape and Lick observations which have not been in all cases eliminated before the observations were combined. A. S. D. M.

2420. Photoelectric Observations of Two Low-Temperature B-Type Stars. W. M. Smart. *Roy. Astron. Soc., M.N.* 89. *pp.* 545–548, *March*, 1929.

In a recent paper [see Abstract 1125 (1929)] Greaves, Davidson and Martin drew attention to the low colour-temperatures of several B-type stars. In the present paper the writer describes his methods for determining the photoelectric colour-index of stars, and assigning the equivalent spectral classes. From his work it appears that Zeta Persei and 9 Cephei, which have been assigned to classes B1 and B2, behave photoelectrically as normal stars of classes A5 and F0 respectively.

M. A. E.

2421. Apparent Displacement of Polaris. E. Esclangon. *Comptes Rendus*, 188. *pp.* 857–860, *March*, 18, 1929.

Polaris is the close circumpolar, observable in daylight, and therefore used to fix the transit instrument azimuth. Observations, during a 19-year lunar cycle, of upper and lower transits, serve for the precise determination of nutation if the exact proper motion of Polaris (a multiple star) is known. A series of 4700 observations were made at Strasburg (1883–1915), of which 2050 were of the *consecutive* lower and (preceding or following) upper transits. If A_i and A_s are the line of sights deduced from such a pair, then $A_i - A_s$ shows a systematic error in the adopted Right Ascension, which error may be due to the actual proper motion of the star, or to faulty constants of nutation (chiefly) or precession; or to both sources together, since neither is sufficient alone to explain the differences $A_i - A_s$. The author assumes for the algebraic sum of these two sources, $A_i - A_s = -\Delta\alpha\,(\tan 2\delta)\,(\cos\phi)^{-1}$ where Δ is the error in R.A., and gives a diagram. He finds as correction to the minor axis of the nutation ellipse $+0''\cdot064$ and to the major $-0''\cdot140$; for the correction to the proper motion, a period of thirty-three years, but the interval elapsed of thirty years is not sufficient to fix this with certainty. He concludes that it is necessary to obtain direct and precise observations of the star's proper motion.

A. S. D. M.

2422. Distances of Variable Stars in the Eta Carinæ Star Clouds. D. B. McLaughlin. *Astron. J.* 39. *pp.* 49–53, *March* 9, 1929.

The variable stars of eclipsing, Cepheid, and long-period types within an area of about 8° centred on the Eta Carinæ nebula, are here discussed. The furthest of the Cepheid variables are about 50,000 light-years away from us, but the star-clouds here are not at equal distances nor of uniform density: they seem to lie in at least four strata, and have a depth several times as great as the distance from the sun to the nebula.

M. A. E.

2423. Indeterminateness in Leuschner's Method of Differential Correction of Orbits. C. H. Smiley. *Astron. J.* 39. *pp.* 54–55, *March* 9, 1929.

The conditions under which Leuschner's method becomes indeterminate are here considered, and it is shown how the indeterminateness may sometimes be avoided by a skilful transformation of coordinates. The discussion is limited to the indeterminate cases which arise out of the method, but these occur only rarely. Those which arise out of uncertainty in the observations are much more frequent, and cause difficulty in every method. Each case of this kind should be treated separately on its own merits, and here Leuschner's method has a great advantage in its ease and accuracy. M. A. E.

2424. Derivation of Radiative Viscosity Equations. E. A. Milne. *Roy. Astron. Soc., M.N.* 89. *pp.* 518–525, *March,* 1929.

The author obtains the general equations of radiative viscosity outright, using the technique of vector and tensor analysis instead of spherical coordinates as Jeans did [see Abstracts 1784 and 2304 (1926)]. The treatment is wholly mathematical. He finds that in his equations the terms involving the gradient of the velocity are just those arising from a coefficient of viscosity: $\mu = 2a\mathrm{T}^4(15c\kappa\rho)^{-1}$ (the same coefficient as obtained by Jeans), where c is the speed of light, κ is the mass-absorption coefficient, T is the temperature measured by a thermometer moving with the medium at any point, B denotes $(\sigma/\pi)\mathrm{T}^4$, where σ is Stefan's constant and $4\pi\mathrm{B}/c = a\mathrm{T}^4$ (the energy-density for a medium *at rest* at temperature T, not the energy-density in the moving medium under discussion). He also finds that the mean pressure p contains a term which is proportional to the rate of expansion of the medium at the point in question; there is thus a second coefficient of viscosity. He finds terms depending on the temperature gradient which differ by a numerical constant from those found by Jeans, who adopted a temperature which is not the local temperature (Milne's T), which alone can have reference to the other properties of the medium at the point. For the terms depending on the gradient of T he writes the equations for the case when the motion is one of uniform motion at right angles to the temperature gradient, and obtains $p_{xy} = v\mathrm{F}_x/c^2$, and $\mathrm{F}y + \frac{4}{3}va\mathrm{T}^4$, and explains their physical meaning. A. S. D. M.

2425. Photometry of Hydrogen and Calcium Lines in Stellar Spectra. Cecilia H. Payne and Emma T. R. Williams. *Roy. Astron. Soc., M.N.* 89. *pp.* 526–538, *March,* 1929.

The two authors have made independent investigations, using differing material and methods; they give tables and diagrams for each. They discuss Milne's papers on line contours (see Abstracts 1113 and 1114 (1929)]. He had predicted that the greater the value of r (intensity ratio) the higher is $\mathrm{T}_{max.}$; that high in the atmosphere—that is, near the line's centre—the temperature at which a given line is " widest " should be lower than for the line's wing—that is, deep in the atmosphere. The authors find that the maximum of the hydrogen lines differ for different levels, but it tends in the opposite sense to Milne's prediction. The same appears in the calcium lines, but less clearly, and it may be that hydrogen behaves anomalously here as elsewhere. In their diagrams of the observed contours it is shown that the higher the temperature the narrower are the extreme wings in comparison with the rest of the line. Milne expected the actual maximum of the H and K lines of ionised calcium to occur at about 5000°, but the authors find the maximum near k_2, and the k_0 temperature probably does not exceed 4200°. There is an indication that the temperature scale is too high all along the spectral sequence. The hydrogen wings have a maximum at Class $\mathrm{A}_3 - \mathrm{A}_5$, and the more central regions at A_0, and A_5 is certainly lower than 11,000°, this disagreeing with Milne's prediction of the maximum of the Balmer lines. The chief result is the value of considering the changes of a line at various levels, and not as regarding it at one part of the star's atmosphere. A. S. D. M.

2426. Coma-Virgo Galaxies. Part I. Transparency of Inter-Galactic Space. H. Shapley and Adelaide Ames. *Harvard Coll. Obs., Bull. No.* 864. *pp.* 1–6, *Feb.*, 1929.

Studies of colour-indices and photographic magnitudes of stars, and of effective wave-length in spiral nebulæ, have led to the belief that there is practically no differential light-absorption in space; and the absence of general light-absorption is indicated by the fact that the angular dimensions of globular clusters decrease with decreasing apparent brightness in the ratio which would be expected in totally transparent space. The test has now been applied to nebulæ in the Coma-Virgo region, where the forms and boundaries of these objects can be more securely determined than when they occur with a rich starry foreground or background. There is a large cloud of two to three hundred nebulæ in an area of some ten degrees, at a distance from us of about ten million light-years, and in the same region there are at least three other smaller clouds, undoubtedly much more remote. A diagram shows the relation of angular diameter to photographic brightness for 2775 of these nebulæ, and since it can be represented by a straight line it is concluded that space, at least in this direction, is effectively transparent throughout a distance of approximately a hundred million light-years. It will be possible shortly to test the transparency of space in other regions in the same way, but meanwhile it seems safe to assume that estimates of the distances of faint outer galaxies are not affected by the scattering of light in space. M. A. E.

2427. Coma-Virgo Galaxies. Part II. Distribution Charts and Frequency Curves. H. Shapley and Adelaide Ames. *Harvard Coll. Obs., Bull.* 865. *pp.* 1–13, *March*, 1929.

2428. Relation of Apparent Magnitudes to Angular Diameters for Globular Clusters. H. Shapley. *Harvard Coll. Obs., Bull. No.* 864. *pp.* 7–9, *Feb.*, 1929.

In Harvard Bulletin 849 a classification of globular clusters was given, and in Harvard Bulletin 852 their apparent magnitudes and angular diameters were further discussed. These data have now been used to test the question of a general scattering of light in interstellar space, in the regions from about 20,000 to 200,000 light-years distant from us, in the same way that transparency of space was tested by extra-galactic nebulæ in regions millions of light-years distant from us [see preceding Abstracts]. The conclusion is reached that here also, in and near our own galactic system, space is effectively clear. M. A. E.

LIGHT.

2429. Absorption of Ultra-Violet Light by some Purine Derivatives and Allied Substances. L. Marchlewski and J. Wierzuchowska. *Acad. Polonaise Sci. et. Lettres, Bull.* 1a. *pp.* 65–79, *Jan.*, 1929. *In English.*

Guanine dissolved in water containing some sodium hydroxide causes two absorption bands in the region between λ2987 and λ2222 with the maxima at λ2460 and λ2744. Adenine (6-aminopurine) investigated as sulphate shows a strong band between λ2973 and λ2162 with the maximum at λ2606. Uric acid shows two bands in the region between λ3137 and λ2280. Allantoin, alloxan and alloxanthine do not show selective absorption, whereas barbituric acid, although differing little in constitution from alloxan, causes selective absorption between λ2747 and λ2370 (maximum at λ2566), and gives an aqueous solution which does not follow Beer's law; it must hence be regarded as a tautomeric substance. On the other hand, diethylbarbituric acid does not show selective absorption, and its aqueous solution adheres to Beer's law. Parabanic acid and urea effect no selective absorption. T. H. P.

2430. Absorption of Ultra-Violet Light by Methyl-d-glucosides. L. Marchlewski and J. Mayer. *Acad. Polonaise Sci. et Lettres, Bull.* 2a. *pp.* 111–118, *Feb.*, 1929. *In English.*

The simple glucosides of *d*-glucose do not cause selective absorption, and as it has been shown previously that *d*-glucose itself, when sufficiently purified, also causes continuous absorption and no bands, it may be regarded as proved that glucose and the glucosides possess similar constitutions, *i.e.*, that the glucose molecule contains no aldehyde group.

T. H. P.

2431. Absorption of Blue Rock-Salt. P. Leroux. *Comptes Rendus*, 188. *pp.* 904–907, *March* 25, 1929.

The effect of rise of temperature on a specimen of blue rock-salt has been observed with the same apparatus as previously used [see Abstract 590 (1928)]. No change was found on heating to 200° C., but a considerable diminution was found on heating to 220° and cooling to 18°, which was increased on subsequently heating to 250°. Similar results were found for parts of the same specimen which were colourless as judged by eye. F. S.

2432. Recording Photoelectric Colour Analyser. A. C. Hardy. *J.O.S.A. and R.S.I.* 18. *pp.* 96–117, *Feb.*, 1929.

The specimen tested and a standard surface of $MgCO_3$ are illuminated, and the reflected beams admitted alternately to the slit of the dispersion system. A narrow band of the spectra produced falls on a photoelectric cell and the current in the cell pulsates when the beams are unequal. The current is amplified, and the alternating part applied to the field coils of a small motor, which in turn controls the diaphragm and varies the illumination on the $MgCO_3$ to secure balance. A pen records on a drum the position of the diaphragm, and rotation of the drum alters the wave-length tested. A complete spectrophotoelectric curve for the entire visible spectrum can be traced in about thirty seconds, and with a reproducibility of 0·05 % or better. To express a colour in terms of three simple numbers an integrating attachment is employed which supplies the degree of excitation of the three primary sensations. R. S. R.

2433. Reflecting Power of Beryllium, Chromium and Several Other Metals. W. W. Coblentz and R. Stair. *Bureau of Standards, Journ. of Research*, 2. *pp.* 343–354, *Feb.*, 1929.

Gives experimentally obtained data on the ultra-violet reflecting power of beryllium, chromium, nickel, silver, stellite and stainless steel for the wave-length range 2500 Å. to 6000 Å. In the case of beryllium and chromium the results are extended into the infra-red. The materials were used in the form of polished metal mirrors, and the results show that beryllium has a much higher reflecting power at 2500 Å. than at the longer ultra-violet wave-lengths. This is contrary to the usual experience with metals, for they usually show a minimum reflectivity between 2500 Å. and 3000 Å. Beryllium has its minimum reflectivity at about 4000 Å. Chromium, on the other hand, has the peculiar property of a high maximum at about 4250 Å., followed by a long flat minimum extending from 6000 Å. well into the infra-red. Further, a comparison of results for chromium with those for nickel shows that chromium is more efficient as a reflector of ultra-violet radiation than nickel, owing to its higher reflectivity in the ultra-violet. For chromium the decrease in reflecting power, produced by continued exposure to ultra-violet radiation, is most marked below 3000 Å., whilst above this wave-length the loss is only about 1 %. R. C. F.

2434. Refraction of Pencils of Luminous Rays. A. Dargenton. *Rev. d'Optique*, 8. *pp.* 4–8, *Jan.*, 1929.

The author develops a simple relation between the solid angle, in the first medium, of a pencil of rays coming from a point in this medium, together with the section of the pencil after refraction, and the corresponding elements when the pencil of rays comes from a point in the second medium. This relation is obtained from a consideration of the general formulæ for the refraction of a pencil of luminous rays when passing from one medium to another. As an example of the use of this simple equation, the relation is obtained between the incident and emergent brightness of a pencil of rays passing through an optical system, and emerging into a medium of different refractive index to that through which it passed before entering the optical system. R. C. F.

2435. Refractive Indices of Water for Wave-Lengths between 23 and 73 cm. E. Frankenberger. *Ann. d. Physik*, 1. 7. *pp.* 948–962, *April* 19, 1929.

The refractive index of pure water is constant at 9·0 over the range from 23 to 73 cm., as is also that of certain aqueous solutions over the range from 50 to 60 cm. T. M. L.

2436. Blue Arcs of the Retina. D. B. Judd. *Bureau of Standards, Journ. of Research*, 2. *pp.* 441–451, *Feb.*, 1929.

The blue-arc phenomenon (Purkinje, Ladd-Franklin, Druault) tentatively linked by the author with a certain phase (the Purkinje phase, or Bidwell's " ghost ") of the periodic after-image following brief stimulation by light of the extrafoveal retina. The Purkinje phase undoubtedly depends on the action of the rods; hence the two phenomena, which are quite similar in some respects, would differ in origin if the blue arcs were really initiated by cone action. As a check on the origin of the nerve-activity producing them, the blue arcs were aroused by pure spectral light

(2° circular field), the retinal illumination being subsequently reduced until the blue arcs no longer appeared. In this way the retinal illumination required to evoke the blue arcs has been determined as a function of wave-length for the author's right eye. A. D.

2437. Light Sensitivity of Animals. S. Hecht. *J.O.S.A. and R.S.I.* 18. *pp.* 264–286, *March*, 1929.

Experiments were carried out upon the clam Mya arenaria, which contracts its siphon when illuminated. A record was taken by means of a mirror attached to the light-sensitive siphon of the animal, and time was measured by means of a tuning fork. Experiments were conducted relating to threshold values of response and stimulation, intensity of discrimination and adaption to light. The photochemical processes entailed are discussed and the Weber-Fechner " all or nothing " law. The action of muscle and nerve in this respect is analogous to the quanta of energy in physics, and recent work shows that contraction of muscle is proportional to the stimulus and corresponds to the number of muscle fibres affected. In nerves the intensity and frequency of the impulses are related. Further sections deal with the distribution of the threshold values of the rod and cones of higher species, and with response in relation to intensity and frequency of the stimuli. B. J. L.

2438. Optical Procedure for Testing Polished Surfaces. A. Arnulf, A. C. S. van Heel and E. Perrin. *Comptes Rendus*, 188. *pp.* 860–861, *March* 18, 1929.

The paper deals with an interference method which can be applied in testing objectives with apertures greater than 0·30, the former method [see Abstract 1501 (1929)] not being applicable for apertures of this magnitude. The results obtained for fourteen objectives, achromatic or apochromatic, are tabulated, showing the mean and maximum errors in microns and in terms of fringe distance, and the method shows an accuracy sufficiently large for most metrological applications. R. S. R.

2439. Effect due to Superposition of Two Regular Systems of Figures. A. Schubnikow. *Zeits. f. Krist.* 69. 5–6. *pp.* 503–510, *Feb.*, 1929.

The author describes an apparatus by which a large number of identical figures can be obtained by photographic means. The results obtained by the superposition of two identical systems of figures to one of which a small angular rotation, ϕ, is given, are shown in the cases of (1) acute-angled triangles, (2) isosceles triangles and (3) parallelograms. The magnification produced in the distance (D) apart of similar lines in the secondary set of figures is given by $a = 2D \sin^2 \phi/2$, where a is the distance apart in the primary figures. R. S. R.

2440. Spectrographic Use of Quartz. J. W. Ellis. *J.O.S.A. and R.S.I.* 18. *pp.* 82–88, *Feb.*, 1929.

The author describes a series of tests made to identify bands in the infra-red obtained with a solution of CCl_4. Errors were introduced by polarisation of the light from the source by reflection losses and by the quartz lens, and by slight departures from parallelism between the optic axis and the surfaces of the quartz end-plates. By using properly cut end-plates the latter is eliminated, but modifications of the energy distribution curve in the infra-red and ultra-violet may be produced in these ways. R. S. R.

2441. Chromium Echelette Gratings for Infra-Red. R. W. Wood. *Phil. Mag.* 7. *pp.* 742–744, *April*, 1929.

Greatly improved echelette gratings have now been made from copper plated with chromium. J. E.

2442. Calibration of Sixty-five 35-Yellow Lovibond Glasses. I. G. Priest, D. B. Judd, K. S. Gibson and Geraldine K. Walker. *Bureau of Standards, J. of Research*, 2. *pp.* 793–819, *April*, 1929.

2443. Experimental Demonstration of Optical Image Formation. C. Lakeman and J. T. Groosmuller. *Zeits. f. Physik*, 53. 9–10. *pp.* 628–638, 1929.

The method described enables the effects to be seen by a large group of persons. A powerful beam of parallel light is incident on the object (*e.g.*, a diffraction grating), and any desired number of the diffraction spectra are collected by a lens objective, and the image of the object so formed is then projected on to the viewing screen, using a weak microscope objective. Photographs are reproduced of the effects obtained, using as object a grating (grating constant = 0·3 or 0·15 mm.; ratio dark to bright line breadth = 1: 5 or 1: 2), and collecting different numbers of the diffraction spectra. In many cases where the image has the same number of bright and dark lines as the object, the relative widths are widely different in the two cases. Photographs using as object crossed gratings are also shown, and the production of Moiré images illustrated. W. S. S.

2444. Image of a Double Slit in Parallel Light. C. Lakeman and J. T. Groosmuller. *Ann. d. Physik*, 1. 6. *pp.* 821–828, *April* 6, 1929.

The authors give an extension of the theory of a previous paper [see Abstract 1837 (1929)]. The two slits in parallel light are now no longer restricted to have width small compared with their distance apart. An experimental confirmation of the theory is described. W. S. S.

2445. Exactitude of Nonius-Divider Readings. K. Lüdemann. *Zeits. f. Instrumentenk.* 49. *pp.* 238–248, *April*, 1929.

Discussion of observations and measurements, old and new, in regard to the above subject. A. D.

2446. Measurement of Aberrations. A. H. Bennett. *Bureau of Standards, J. of Research*, 2. *pp.* 685–702, *April*, 1929.

An interference method for the determination of the axial and oblique monochromatic aberrations of a lens system is described. Equations necessary in the design of the apparatus and for the computation of the results are given. The simplicity of the apparatus, especially the use of but one auxiliary reflecting surface, lessens the probability of large instrumental errors. The aberrations of three astronomical objectives are investigated, and the results are expressed in the form of phase contours. AUTHOR.

2447. Hartmann's Relation for Calibrating Spectral Apparatus. F. Hoffmann. *Phys. Zeits.* 30. *pp.* 238–239, *April* 15, 1929.

Shows how Hartmann's dispersion formula can be used to calibrate the graduations of a prismatic spectroscope, so that tables can be prepared giving the graduations corresponding to given values of the wave-length or of the vibration frequency. Calls attention to the shorter method of calculation given recently by Russell and Shenstone, and shows that it is not nearly as accurate as the original method. H. N. A.

2448. New Optical Adjusting Device for Delicate Levelling. H. Heckmann. *Zeits. f. Instrumentenk.* 49. *pp.* 204–207, *April,* 1929.

The levelling instrument has a plane parallel plate of glass situated in the telescope between the objective and cross-wires, and rotated by a screw giving fine adjustments. A thread is rotated with the plate, and its image coincides with the plane of the cross-wires. At zero setting this thread coincides with the intersection of the cross-wires and the glass plate is perpendicular to the axis of the telescope, while the zero of a subdivided scale is also focussed on the cross-wires. The instrument is light, easy to manipulate and the errors in use are small. With the scale adjustment levelling is possible to ± 0″·5 or to ± 0·17 mm. for a distance of 50 m. R. S. R.

2449. Measurements of the Velocity of Light. O. Mittelstaedt. *Phys. Zeits.* 30. *pp.* 165–167, *March* 15, 1929. *Paper read before the Deut. Phys. Gesell., Leipzig, Jan.*, 1929.

In a table is set out the method used by a number of experimenters since 1848, the medium employed and the value obtained for the velocity, together with the probable error. From this table Gheury and Bray indicated that the velocity appeared to be decreasing by 3 km. sec. per year. In their latest tests, Karolus and the author obtained errors of ± 20 km. [see Abstract 466 (1929)], but further tests, in which the errors will be halved, are proposed, and these will help to test this suggestion. R. S. R.

2450. Theory of Optical Activity in a Homogeneous Medium. R. de Mallemann. *Comptes Rendus,* 188. *pp.* 705–707, *March* 4, 1929.

The case considered is that of a homogeneous medium which is anisotropic, *e.g.*, a uniaxial or biaxial crystal. In this case the rotatory power of the medium is not constant, but varies with the direction of propagation. It is pointed out that, according to the theory now advanced, active crystals possessing a plane of symmetry cannot exist. T. M. L.

2451. Magnetic Rotatory Power in an Anisotropic Medium. R. de Mallemann. *Comptes Rendus,* 188. *pp.* 863–865, *March,* 18, 1829.

Anisotropy of magnetic rotatory power results from anisotropy of birefringence of electrons, atoms and molecules. T. M. L.

2452. Optical Activity of Quartz Perpendicular to the Optic Axis. G. Szivessy and C. Schweers. *Ann. d. Physik,* 1. 7. *pp.* 891–947, *April* 19, 1929.

It is shown that the results of Voigt and the deductions of Wever as to the origin of optical activity of α-quartz perpendicular to the optic axis are incorrect, being produced by secondary causes, such as lack of parellelism of the light. T. M. L.

2453. Light Quanta. G. Wataghin. *N. Cimento,* 6. *pp.* 41–49, *Feb.,* 1929.

The author propounds a model for the motion of light-quanta which is in accord with interference, diffraction and polarisation. Maxwell's equations are treated as macroscopic equations, which govern the statistical behaviour of luminous corpuscles. Shown that certain difficulties suggested by N. Bohr and W. Pauli in the corpuscular interpretation of interference may be overcome by having regard to reciprocal action between the quantum and the atoms constituting the interferential apparatus or the outline of the field. The corpuscular interpretation of polarisation and of the production of stationary waves developed. A. D.

2454. Theory of Light Scattering in Liquids. C. V. Raman. *Phil. Mag.* 7. *pp.* 160–161, *Jan.*, 1929.

An answer to a note by Rocard, who criticises (*ibid.*, 6. pp. 204–205, July, 1928) the author's theory of light scattering [see Abstract 1566 (1928)]. G. E. A.

2455. Maxwell-Lorentz Electromagnetic Theory and the Molecular Diffusion of Light. J. Cabannes and Y. Rocard. *J. de Physique et le Radium*, 10. *pp.* 52–70, *Feb.*, 1929.

The character of the light diffused by a fluid of which the molecules are anisotropic is worked out on purely classical lines, and it is shown that the theory predicts, besides diffused light of the incident frequency N, secondary radiations of frequency $N + n$ and $N - n$, the intensities of the latter being in the proportion $\left(\frac{N+n}{N-n}\right)^4$. The secondary radiation is always less completely polarised than the principal radiation. In practice the secondary radiations due to rotations of the molecule from a system of lines which lie near to the principal frequency, and are easily masked by the Cabannes-Daure broadening of the latter. Secondary radiations due to vibration of the molecule are, however, widely separated from each other and have been studied extensively (Raman Effect). Experiment shows that these secondaries occur in pairs, of frequencies $N + n$ and $N - n$, but that the intensity of the higher frequency $(N + n)$ is feeble compared with that of the lower frequency. Another inconsistency with the classical theory, observed experimentally in certain cases, is a more complete polarisation of the secondary frequency than of the principal radiation. The quantum viewpoint leads to a theory which fits in with the more detailed experimental findings. W. S. S.

2456. Diffused Radiation in an Infra-Red Spectrometer. J. Lecomte. *Comptes Rendus*, 188. *pp.* 622–625, *Feb.* 25, 1929.

The method proposed for detecting the presence of radiations shorter than 10μ when investigating the longer-wave region is to replace the usual opaque shutter by one transparent to the short-waves only, *e.g.*, glass or fluorite. The objection to the method is that the detector will receive some radiation throughout the series of observations, and thus be continually heated. To overcome this it is proposed to find the amount of diffusion once for all, the method of correction being indicated. F. S.

2457. Raman Effect. A. Carrelli. *Accad. Lincei, Atti*, 9. *pp.* 165–169, *Jan.* 20, 1929.

Refers to an earlier paper [see Abstract 1513 (1929)], and confirms the conclusions there by deduction from published observations. A. D.

2458. Raman Effect and Negative Absorption. B. Rossi. *Accad. Lincei, Atti*, 9. *pp.* 319–324, *Feb.* 17, 1929.

The current interpretation of the Raman effect as an experimental proof of Einstein's postulated induced emission or negative absorption (negative Einstrahlung) leads to serious difficulties. If Einstein's induced emission be assimilated to a Raman effect of the second species, it ought to have a frequency double of that absorbed or spontaneously emitted by the atom. The present paper is devoted to an accurate analysis of the phenomenon, which brings out that the Raman effect and the induced emission are different in kind, the former being due to a super-elastic shock between a quantum of light and an excited atom, while the latter is a modification of the probability that an atom has of emitting a radiation of a given frequency as an effect of the presence of other quanta of the same frequency. A. D.

2459. Raman Effect in Water. E. H. L. Meyer. *Phys. Zeits.* 30. *p.* 170, *March* 15, 1929.

Observations have been made by the author and J. Port, using a mercury arc lamp. Two broad bands have been found, which vary very much in intensity with temperature. At 11° C. the band at 4690 Å. is scarcely visible, while that at 4250 Å. is very strong, and at 100° C. the relation s reversed. From observations of Venkateswaran and Karl on the Ramani effect in alcohols it appears that the 4690 Å. band is due to vibrations of OH —. The 4250 Å. band seems to be due to molecular aggregates; it is strong at low temperatures and vanishes at high temperatures, when the aggregates are resolved into separate molecules. H. N. A.

2460. Raman Effect in Some Organic Liquids. S. Venkateswaran. *Phil. Mag.* 7. *pp.* 597–600, *March*, 1929.

The Raman spectra of acetic, proprionic and butyric acids consist of a set of rather broad and diffuse lines, together with a continuous spectrum. A continuous spectrum has been observed previously with a viscous glycerine [see Abstract 135 (1929)]. Since the intensity of this continuous spectrum is nearly the same in acetic and proprionic acids, but much greater in the more viscous butyric acid, it is suggested that there is some connection between the viscosity and the existence of a continuous spectrum. The infra-red frequencies for acetic and butyric acids calculated from the Raman lines agree well with the measurements of Coblentz and Wneiger. F. J. W.

2461. Broadening of Spectral Lines by Molecular Diffusion. J. Cabannes and P. Salvaire. *Comptes Rendus,* 188. *pp.* 907–908, *March* 25, 1929.

Broadening and displacement towards the red of 4358 Å. due to molecular diffusion in a gas has been previously observed with a Fabry-Perot etalon [see Abstract 2676 (1928)]. A similar effect, which is comparable to the Compton effect, has now been observed in a number of liquids using a much shorter etalon. F. S.

2462. Fine Structure of the Light Diffused at Critical Opalescence in Connection with the Cabannes-Daure Effect. A. Bogros and Y. Rocard. *J. de Physique et le Radium,* 10. *pp.* 72–77, *Feb.*, 1929.

It is shown by experiment that the light diffused by an opalescent binary mixture (water-phenol) exhibits precisely the same fine structure as the exciting radiation, a result in apparent contradiction with the broadening of spectral lines in the diffused light from gases and liquids (Cabannes-Daure effect). The possible theoretical explanations of the effects observed are examined and it appears that the broadening of the lines in the Cabannes-Daure effect cannot involve all the diffused light, but only that due to the variable part of the electric moment of the diffusing molecules. Adopting this view the presence of broadening in ordinary diffusion and its absence in opalescence can be reduced to a common explanation. W. S. S.

2463. Secondary Radiations in Light Diffused by Calcite. J. Cabannes. *Comptes Rendus*, 188. *pp.* 1041–1043, *April* 15, 1929.

Nine secondary radiations from + 280 to − 1750 (waves per cm.) have been observed in the diffusion spectrum of calcite, the strongest being band 283 and ray 1083. Considering the secondary rays as emitted by virtual oscillators, polarisation experiments with different directions of incident light relative to the crystal axis permit the calculation of the mean square of the displacement of the oscillators along three perpendicular axes. The relations between the direction of the exciting radiation and the displacement of the oscillators are considered in the cases of the two principal secondary rays [see Abstract 1858 (1929)]. A. J. M.

2464. Development of Spectrographic Negatives. E. Viterbi. *N. Cimento*, 6. *pp.* 36–39, *Jan.*, 1929.

Tests for fine-grain work. Developers tested: some physical developers, those with paraphenylenediamines, and those rich in sodium sulphite and very faintly alkaline. The last gave the best results, and clearly separated lines at a mutual distance of only 0·2 to 0·3 Å., even with a spectograph of medium dispersion. A. D.

2465. Three-Colour Carbro Process. F. J. Tritton. *Phot. J.* 69. *pp.* 174–179, *April*, 1929.

An explanation of certain practical points in the Carbro process. A. D.

2466. Evolution of the Latent Image. G. Jausseran. *Comptes Rendus*, 188. *pp.* 783–785, *March* 11, 1929.

From an examination of the density of the photographic image developed at various times after exposure, the author shows that considerable variations of the density due to the evolution of the latent image occur. Below densities of 1·0 the value of the density decreases slightly with increase of time between exposure and development up to approximately two hours, after which the decrease becomes somewhat less marked. Above densities of 1·0 the density values increase with time, approaching a steady value after a time which is apparently a function of the density. An error of two to one can be obtained in the photographic comparison of two intensities which have not been photographed simultaneously. The evolution of the latent image thus becomes slower with time, and if the plate be left long enough the density tends to reach a steady value. This fact is especially valuable in photographic photometry. R. C. F.

2467. Photographic Action from Metals, Woods, etc. J. G. Strachan. *Roy. Techn. Coll., Glasgow, J.* 2. *pp.* 20–29, *Jan.*, 1929.

Experiments are described showing the photographic effect produced in the dark by certain metals, woods and liquids. Although it was subsequently found that the phenomenon had been thoroughly investigated about thirty years ago, it has been thought desirable to recall attention to a subject which does not seem to be well known. AUTHOR.

2468. Photographic Plates. Bleaching by Desensibilators. Lüppo-Cramer. *Zeits. f. Wiss. Phot.* 26. *pp.* 344–351, *April*, 1929.

The bleaching which a pre-illuminated plate after steeping in some desensibilators undergoes in the light is not less but greater the more dilute the solution used, within working limits. A. D.

2469. Motion Pictures in Relief. H. E. Ives. *J.O.S.A. and R.S.I.* 18. *pp.* 118–132, *Feb.*, 1929.

The author describes a parallax panoramagram which, while possessing severe practical limitations, is claimed to be theoretically sound and provides an experimental realisation of motion pictures in relief. The camera described earlier [see Abstract 1162 (1929)] is modified, and several cameras provide a series of pictures seen through an opaque-line screen, the composite picture seen through the grating spaces giving a stereoscopic image. The method of replacing cameras by projectors to obtain the motion picture is described for the simplest case, together with lines of development. R. S. R.

2470. Photometry of Neon Lamps. C. Fabry, L. Roux and E. Perrin. *Rev. d'Optique*, 8. *pp.* 1–3, *Jan.*, 1929.

In order to facilitate the photometry of neon lamps the present authors have produced a liquid filter which transmits light of the same colour as that emitted by the neon lamps, when used in conjunction with an ordinary carbon filament photometric standard lamp. The filter, which consists of a mixture of potassium chromate, sulphuric acid and water in a glass cell 110 mm. thick, is placed between the photometric screen and the carbon lamp, allowance being made for the alteration in distance between the photometric screen and the lamp due to refraction. The intensity of the light, after passing through the filter, was calculated from the curve of relative visibility of the radiations, the spectral energy intensity curve of the lamp, and the spectral transmission curve of the cell. R. C. F.

2471. Life-Characteristics of Nernst Filament. P. C. Mahanti and R. N. Das Gupta. *Journ. Sci. Instruments*, 6. *pp.* 95–99, *March*, 1929.

Describes the results of a study of the radiation, especially in the infra-red, from a linear Nernst filament. Curves of spectral energy distribution are given for a filament which was run for a total of nearly 700 hours. There was a gradual shift of the maximum with lapse of time, the change being from 2·6 to 1·7 μ. The curve of energy distribution does not exactly follow that of a black-body. The colour temperature is about 2320° K. There is a marked structural change in the filament produced by continued operation. J. W. T. W.

2472. Possibility of Signalling by Means of Ultra-Violet Radiation. Y. Rocard. *Rev. d'Optique*, 8. *pp.* 9–15, *Jan.*, 1929.

Compares the ultra-violet radiation emitted by a quartz mercury-vapour lamp and a carbon arc lamp, using a fluorescent screen method, in which the visible light is cut off by means of a Wood's glass. The results show that the carbon arc is greatly superior to the mercury-vapour lamp in this respect. A further examination, in which only part of the image of a carbon arc passes through the Wood's glass, allows of evaluation of the luminous output from the fluorescent spot produced by the ultra-violet light. A comparison of the limiting range obtained, using the fluorescent screen method and a photoelectric cell method, shows that the fluorescent screen is the better. Transmission curves for samples of Wood's glass are also given, showing a maximum transmission at 3600 Å., and cut off at approximately 3200 Å. and 4000 Å. R. C. F.

2473. Excitation of Solid Bodies by Slow-Speed Electrons. S. Ziemecki. *Acad. Polonaise Sci. et Lettres, Bull.* 8*A*. *pp.* 367–373, *Oct.*, 1928. *In English.*

In the case of five very different substances (calcium oxide, zirconium oxide, calcium sulphide, willemite, samarium), having specially brilliant kathode-luminescence, the author shows that, contrary to accepted opinion, the excitation-potential of solids by electrons is of the same order of magnitude as the excitation-potential of gases. It seems probable, according to this result, that the explanation of these phenomena should be looked for in the quantum theory. A. D.

2474. Influence of Boric Acid on Phosphorescence of Zinc Sulphide Prepared by Explosion. F. Prevet. *Comptes Rendus*, 188. *pp.* 903–904, *March* 25, 1929.

Improved products are obtained in presence of 5 to 20 % of boric acid. T. M. L.

2475. Chemiluminescence. E. K. Rideal. *Nature*, 123. *pp.* 417–419, *March* 16, 1929.

The present paper is based on a lecture, with experiments, delivered at the Royal Institution. It is stated that chemiluminescence may be assumed to be in many cases the result of liberation of chemical energy in a form similar to that of fluorescent energy for chemiluminescence occurs in reactions wherein a large number of excited molecules are produced by chemical reaction. It is suggested that in the oxidation of phosphorus,. sulphur and probably many other substances the chemiluninescence observed is the result of some type of branching chain mechanism—that is, where one elementary reaction produces at least two reacting molecules. In chain or cluster reactions the inhibition produced by small quantities of inhibitors is noted, and in this connection the inhibiting effects of benzene and ether on the glow of phosphorus is referred to. A large number of chemiluminescent reactions taking place in solution and otherwise is referred to. J. K.

2476. Radiant Energy on Plants. J. M. Arthur. *J.O.S.A. and R.S.I.* 18. *pp.* 253–263, *March*, 1929.

Experiments were conducted upon various plant species which were grown in five different glasshouses, the glazing of which screened out different regions of the sun's spectra. The results show great variations as regards growth in relationship to the spectra. Other experiments were conducted under artificial light, and it is found that continuous illumination hinders growth, and growth and flowering is related to the length of the artificial day. The paper is of considerable interest. B. J. L.

2477. Physicist's Concept of Light. P. R. Heyl. *J.O.S.A. and R.S.I.* 18. *pp.* 183–192, *March*, 1929.

A brief historical account is given in popular language of the development of the wave and corpuscular theories of light and of the quantum and ether concepts. W. S. S.

2478. Broadening of Lines by Resonance. A. Carrelli. *Accad. Lincei, Atti*, 9. *pp.* 222–225, *Feb.* 3, 1929.

Comments on and developes Holtzmark's theory [see Abstract 542 (1926)]. Experimental data. A. D.

2479. Stark Effect of Helium 2P–6D Line by Quantum Mechanics. Y. Fujioka. *Inst. Phys. and Chem. Research, Sci. Papers, No.* 181. *pp.* 99–106, *Feb.* 19, 1929.

Applies the method employed by Foster in calculating the displacements and relative intensities in the Stark effect of helium lines using Heisenberg's matrix quantum mechanics to a member of the diffuse series of parahelium, 2P–6D, $\lambda = 4144$ Å., higher than those observed by Foster; the theoretical values obtained showed fairly good agreement with the author's experimental results. The paper concludes with a table showing the Stark displacements of the lines of the group, and their relative intensities with different fields. Diagrams show the theoretical displacements and intensities, and photographs of the spectrum showing the Stark effect are reproduced. H. N. A.

2480. Helium Band Spectrum. S. Imanishi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 184. *pp.* 193–209, *March* 23, 1929.

This is a continuation of the work of Dieke, Takamine and Suga [see Abstract 3016 (1928)], with the same spectrograph, but an improved discharge tube. The results of measurements in the region 3180–3570 are given. Three new bands, $2S(n = 0) - 7P(n = 0)$, $2S(n = 0) - 8P(n = 0)$, and $2S(n = 0) - 5P(n = 1)$ are found, and completely identified. In addition, the $2S(n = 0) - 5P(n = 1)$ and $2S(n = 1) - 5P(n = 0)$ bands of ortho-helium are completed up to the first line in every branch; and a more extensive observation of Curtis' band $2S(n = 0) - 5P(n = 0)$ is made. F. S.

2481. Analysis of the Band Spectrum of Helium. W. Weizel. *Zeits. f. Physik*, 54. 5–6. *pp.* 321–340, 1929.

The author gives first a sketch of the wave-mechanics theory of the emission spectrum of the diatomic molecule He_2. The symmetry characteristics of the terms are derived, and the selection principles laid down. The theoretical admissible 15th order manifold of terms is restricted by setting two of the electrons in the " ground orbit " ($1s\sigma$), the third electron in the $p\sigma$ state, whilst the fourth or dispersion electron moves in a three-fold set of states. This arrangement accords with the empirical analysis of the helium-band spectrum. In the second part, further experimental measurements on the He_2 band spectrum are reported. These enable the oscillation quanta of a number of electronic states to be determined. For intense excitation the oscillation quanta converge on a value 1620 cm^{-1}, the oscillation quantum of the He_2^+ ion. By regarding the oscillation quantum as a measure of the strength of the molecular binding a number of conclusions are drawn as to the effect of adding to the ion, He_2^+, an electron in different quantum levels. As upper limit to the heat of dissociation of He_2, the value 55,000 cal./mol. is obtained. W. S. S.

2482. Combination Spectra of Ions and Electrons in Cæsium and Helium. F. L. Mohler and C. Boeckner. *Bureau of Standards, J. of Research*, 2. *pp.* 489–500, *March*, 1929.

Thermionic discharges in cæsium and helium were operated to give strong continuous bands and spectrophotometric measurements of intensity made in connection with probe-wire measurements of electrical conditions. The factors relating discharge conditions and intensity were studied in detail. The cæsium afterglow was photographed with a sectored disc and commutator. The results of intensity distribution are explained on the basis of simple recombination. F. S.

2483. Singlets and Triplets in the Spectra of Two Electron Systems. W. V. Houston. *Phys. Rev.* 33. *pp.* 297–304, *March*, 1929.

The Darwin-Pauli treatment of the electron is applied to the Schrödinger equation for a two-electron system. The results show that the division into singlets and triplets is justified only as a limiting case. Expressions are derived which give the position of the levels, the Zeeman-effect pattern, and the intensities of the lines when the division into singlet and triplet cannot strictly be made. These expressions are shown to give the observed facts of several spectra. AUTHOR.

2484. Molecular Spectrum of Ammonia. Part I. Two Types of Infra-Red Vibration Bands. G. A. Stinchcomb and E. F. Barker. *Phys. Rev.* 33. *pp.* 305–308, *March*, 1929.

The NH_3 absorption bands at $3\cdot0\,\mu$ and at $1\cdot9\,\mu$ have been sufficiently resolved by means of gratings to reveal their fine structure, which proves to be of a different character in the two cases. The $3\,\mu$ band is associated with a vibration of the electric moment parallel to the symmetry axis of the molecule, yielding one zero branch and a simple rotation series. At $1\cdot9\,\mu$ a series of almost equally spaced lines is observed, showing a remarkable uniformity in intensity so that the envelope is a single broad maximum instead of the usual doublet. The band centre cannot be selected by inspection. The vibration which gives rise to this band is normal to the symmetry axis. From the $3\,\mu$ band the moment of inertia of the molecule ($I = 2\cdot83 \times 10^{-40}$) about a line normal to the symmetry axis may be determined, but this does not yield the distances between atomic nuclei. The $1\cdot9\,\mu$ band probably corresponds to one of the four fundamental frequencies. Because of its character it cannot be a harmonic, nor can it be a combination of vibrations along the axis as had previously been supposed. The $10\,\mu$ and the $6\,\mu$ bands probably correspond to two other fundamentals, but the selection of the fourth fundamental and the characterisation of the combination bands must await further analysis to determine the nature of the vibrations involved. AUTHORS.

2485. Efficiency of Quenching Collisions and the Radius of the Excited Mercury Atom. E. Gaviola. *Phys. Rev.* 33. *pp.* 309–318, *March*, 1929.

The evidence in favour and against the assumption of Foote that every collision of a foreign gas molecule with an excited mercury atom is efficient in quenching the resonance radiation is discussed, and a new calculation of the efficiency of collisions is given, based on Stuart's measurements, which shows that the efficiency can be assumed to be equal to one in the case of CO, H_2 and perhaps O_2, but that it is undoubtedly smaller than one for H_2O, N_2, A and He. CO has actually a greater quenching efficiency than H_2. The radius of the excited mercury atom is calculated, using an improved value for the amount of resonance radiation reabsorbed in the resonance vessel and found to be $r_{Hg'} = 2\cdot91 \times 10^{-8}$ cm, or $1\cdot62$ times larger than the radius of the normal atom for the case of H_2, and $r_{Hg'} = 5\cdot5 \times 10^{-8}$ cm, or threefold normal for the case of CO. The apparent higher quenching efficiency of oxygen than hydrogen is explained by the partial oxidation of the mercury vapour and consequent decrease of the density of the last. It is shown that the life of metastable atoms increases with the admission of certain foreign gases into the fluorescence vessel. AUTHOR.

2486. Intensity Measurements in the Band Spectrum of Mercury Hydride. W. Kapuściński and J. G. Eymers. *Zeits. f. Physik*, 54. 3–4. *pp.* 246–256, 1929.

The intensity distribution in nine bands of the band spectrum of mercury hydride was investigated photometrically under various discharge conditions and compared with the theory of Hill and van Vleck. The results are given in tables and curves. The experimental distribution differs from the theoretical in that the higher rotation conditions appear relatively too strong. For six bands the end of the band was determined. A. W.

2487. Band Spectra of Mercury, Cadmium and Zinc Halides. K. Wieland. *Helv. Phys. Acta*, 2. 1. *pp.* 46–76, *and* 2. 2 *pp.* 77–94 and 144, 1929.

Band spectra of mercury, cadmium and zinc halides have been activated in Geissler tubes and studied over the range of wave-length 7000–2300Å. Three types of band systems are distinguished. In the first the band heads fit series formulæ of the Deslandres type. The bands are due to the diatomic molecules HgCl, HgBr, CdI, CdBr and ZnI. Further, Mulliken's isotope equation is satisfied. The second type of band systems have a triple structure, and are due to the triatomic molecules $HgCl_2$, $HgBr_2$, etc. Band systems of the third type consist of partly diffuse bands and continuous spectra. No quantitative relationships could be deduced, and it is not clear what gives rise to them. F. J. W.

2488. Persistence of λ2537 in Mercury at Low Pressures. H. W. Webb and Helen A. Messenger. *Phys. Rev.* 33. *pp.* 319–328, *March*, 1929.

The persistence of λ2537 excited by electron impact in mercury vapour was measured for vapour pressures corresponding to the temperature range 78° C. to − 19° C., using the alternating potential method previously described by one of the authors. Between 78° C. and 17° C. this persistence was found to vary inversely as the first power of the pressure, and not inversely as the square of the pressure as predicted by theories of the diffusion of radiation by repeated absorption and re-emission. A modified theory of diffusion of radiation seems necessary to explain the persistence, which is much too small to be explained as depending upon the life of the metastable atoms. As the pressure is lowered the persistence approaches a limiting value of the order of 10^{-7} second. The life of λ1849 was found to be less than 3×10^{-9} second. A radiation process probably associated with the 7·1 break in the critical potential curves was found to have a life of 1/470000 second. It is suggested that this is the life of an infra-red transition to the 6·7-volt level, followed by the radiation of 1849. Another process associated with an excitation potential lying between 5 and 6 volts had a life of about 1/120000 second. AUTHORS.

2489. Excitation of Sodium by Ionised Mercury Vapour. H. W. Webb and S. C. Wang. *Phys. Rev.* 33. *pp.* 329–340, *March*, 1929.

An auxiliary electrode in the ionised vapour from a mercury arc increased the number of excited atoms, and the spectra excited by both were compared. It is concluded that the excitation of a sodium atom by a mercury ion is due to a three-body impact involving a mercury ion, a sodium atom and an electron. The spectrum excited by ionised mercury resembles the chemiluminescence spectrum due to mixing sodium and mercuric chloride vapours. The spark line of mercury λ3984 was found in the presence of sodium. F. S.

2490. Spectral Absorption of Certain Monoazo Dyes. W. R. Brode. *Bureau of Standards, J. of Research*, 2. *pp.* 501–540, *March*, 1929.

Quantitative measurements of the spectral absorption of solutions of azobenzene, benzeneazophenol, and the mono- and dimethyl derivatives of benzeneazophenol in alcohol, aqueous hydrochloric acid, and aqueous sodium hydroxide are recorded and their relationships discussed. Although the differences found in the spectral absorption of alcohol solutions or of hydrochloric acid solutions of the position isomers studied are small, marked differences are found in the absorption of 3 % aqueous sodium hydroxide solutions. AUTHOR.

2491. Absorption Spectra of Ortho-, Meta- and Para-cresols. J. Savard. *Comptes Rendus*, 188. *pp.* 782–783, *March* 11, 1929.

The ultra-violet absorption spectra of the vapours of ortho- and meta-derivatives are characterised by double band heads, while those of the para-derivatives show single heads. The probable molecular structures are discussed. F. S.

2492. Modulation of Light Waves. A. Bramley. *Frank. Inst., J.* 207. *pp.* 315–321, *March*, 1929.

Light was passed through a Kerr cell filled with water, to which were applied high-frequency oscillations of a wave-length of about 8 metres. In the case of an iron arc only one line out of fifteen between 2480 Å. and 2500 Å. was displaced, a shift towards the red of 0·06 Å. being observed. The 2536·5 Å. line of mercury was also found to be shifted towards the red relative to the 2534·7 Å. line. The effect is independent of the temperature of the water and of the oscillatory current, but dependent upon the wave-length of the high-frequency waves. F. S.

2493. Coordination Questions, in Particular the Ordering of Multiplet Terms to Series Limits. F. Hund. *Zeits. f. Physik*, 52. 9–10. *pp.* 601–609, 1928.

The problem considered is the ordering of the terms of a quantum mechanical system for different values of a parameter; for example, the ordering of the Zeemann components for weak and strong magnetic fields. The problem is not always rigorously definable, and in many cases an intrinsic ambiguity is involved. A number of general rules based on the symmetry properties of the eigen functions are enunciated as governing term coordinations, and in order to completely define the process the additional principle is laid down that no crossing over of terms shall occur except those required from symmetry considerations. The following special systems are discussed: terms in combined magnetic and electric fields, variation of the term structure of diatomic molecules for increasing rotation, and ordering of multiplet components to series limits. Some of the author's previous conclusions on this subject are shown to have only a very restricted application. [*Linienspektren*. 1927.] W. S. S.

2494. Spectrum of H_2. Bands Analogous to the Parhelium Line Spectrum. O. W. Richardson and P. M. Davidson. *Roy. Soc., Proc.* 123. *pp.* 54–80, *March* 6, 1929.

The systems of bands previously reported [see Abstract 344 (1928)] are re-examined with the help of the new tables of the spectrum published by Gale, Monk and Lee. Instead of 6 progressions with a maximum of 4 members each, over 50 progressions, several of them extending to 9 members, are now identified. These include the strongest lines of the secondary spectrum from $\lambda = 3394$ to $\lambda = 8902$. The lines of all bands are single, the irregular doublets previously described being separate lines of the same or related bands. The final states of all these progressions belong to the electronic state 2'S, the bands representing that part of the H_2 spectrum which is analogous to the parhelium line spectrum. No combinations between any of the lines of these bands and those of the α, β, γ, etc., bands occur. The final states seem to be the same as the B states of Dieke and Hopfield, and the lines will presumably combine with those of the Lyman bands. W. S. S.

2495. Spectra of Alkali Metals Excited by Active Nitrogen. J. Okubo and H. Hamada. *Phil. Mag.* 7. *pp.* 729–736, *April*, 1929.

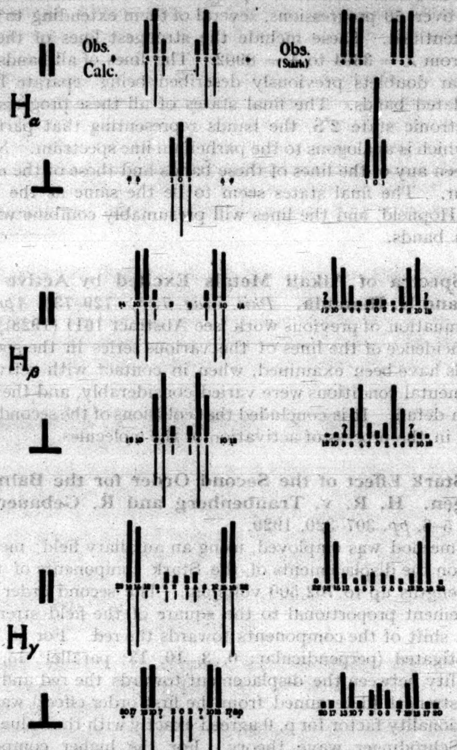
In continuation of previous work [see Abstract 1611 (1928)], the intensities and incidence of the lines of the various series in the spectra of the alkali metals have been examined, when in contact with active nitrogen. The experimental conditions were varied considerably, and the results are discussed in detail. It is concluded that collisions of the second kind are of importance in the process of activation of the molecules. J. H. A.

2496. Stark Effect of the Second Order for the Balmer Series of Hydrogen. H. R. v. Traubenberg and R. Gebauer. *Zeits. f. Physik*, 54. 5–6. *pp.* 307–320, 1929.

Stark's method was employed, using an auxiliary field; measurements were made on the displacements of the Stark components of the Hγ line for field strengths up to 702,500 volts/cm. The second order effect, *i.e.*, the displacement proportional to the square of the field strength, corresponds to a shift of the components towards the red. For all the components investigated (perpendicular: 0, 3, 10, 13; parallel: 15, 18), strict proportionality between the displacement towards the red and the square of the field strength (determined from the first order effect) was observed. The proportionality factor for p. 0 agreed exactly with the value computed, using the Schrödinger wave theory. For the higher components the proportionality factor exceeded the Schrödinger theoretical value. This discrepancy is related to gas in the experimental tube, measurements at lower pressure tending to converge on the Schrödinger result. The proportionality factor computed from Epstein's classical quantum theory of the Stark effect falls below the experimental value for all components, including p. 0 and in every case agrees less well with observation than does the wave theory value. W. S. S.

2497. Relative Intensities of Stark Components in Hydrogen. J. S. Foster and Laura Chalk. *Roy. Soc., Proc.* 123. *pp.* 108–118, *March* 6, 1929.

Three lo Surdo tubes suitable for the study of Stark component intensities are described. Quantitative measurements of the stronger Stark components of the Balmer lines α, β, γ and δ were carried out, using a neutral wedge photograph on the experimental plates as comparison scale, and a Moll photometer for measuring the densities. The results agree within experimental error with the theoretical (wave mechanics) calculations of Schrödinger. The accompanying figure indicates the improved correspondence between the theoretical and present observational results over the earlier experimental results due to Stark. W. S. S.



2498. Broadening of Spectral Lines by Pressure. G. Joos. *Phys. Zeits.* 30. *pp.* 168–169, *March* 15, 1929.

Deals with the problem from the point of view of quantum mechanics. Instead of the electrodynamical effect of the revolving electrons, as in the classical theory, the energy of reciprocal action of the quantum theory as calculated by Heitler and London is considered. If the amount of disturbance caused by a hydrogen atom acting on another hydrogen atom is taken as a measure of the order of magnitude of the disturbance in the case of other atoms, very small values are obtained for the alterations of frequency at atmospheric pressure, which do not account for the observed broadening, but may represent the small change in position of the maximum of intensity. For greater distances between the atoms the polarisation, which is neglected by Heitler and London, must be taken into account, and in addition to this the thermal movements largely affect the broadening. H. N. A.

2499. Spectrum of Krypton. W. Gremmer. *Zeits. f. Physik,* 54. 3–4. *pp.* 215–226, 1929. *From the Reichsanstalt.*

The arc spectrum of krypton has been measured, using prism and grating spectographs as far as 9752 Å. A number of constant frequency differences has been found and the principal series shown to be an S*p*-combination as Paschen found for Neon. Tables are given of calculated terms and their combinations, together with lines in the spectrum which have been identified. F. S.

2500. Arc Spectrum of Samarium. S. P. de Rubies. *Comptes Rendus,* 188. *pp.* 780–781, *March* 11, 1929.

The arc at normal pressure has been investigated, using the oxide prepared by Urbain, and 120 lines between 3100 Å. and 2750 Å. are listed. F. S.

2501. Optical Investigation of Perylene and its Derivatives. Part II. Visible Absorption Spectrum of certain Di-derivatives. A. Dadieu. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 253–261, *Feb.,* 1929.

Measurements were made to ascertain the influence on the visible absorption bands of the perylene spectrum [see Abstract 129 (1929)] of the following substituents: $CO . C_2H_5$, $CO . C_3H_7$, $CO . C_6H_4 . CH_3$ (ortho), $CO . C_6H_4 . OCH_3$ (para), $[NO_2]_2$ (3 : 10—) and $[NH_2]_2$ (3 : 10—). The influences are not fundamentally different from those of the substituents previously investigated, the bands showing displacement, broadening and change in intensity. For the two perylenequinones also examined the absorption relations are entirely different from those of perylene itself.

T. H. P.

2502. Absorption of Light by some Organic Substances. L. Marchlewski and O. Wyrobek. *Acad. Polonaise Sci. et Lettres, Bull.* 2*a. pp.* 93–110, *Feb.,* 1929. *In English.*

The absorption spectra of pyridine, quinoline, phenylacetic acid, phenylglycollic acid, benzilic acid, menthol, menthone, *m*-bromophenol and benzyl alcohol are described. In all cases Beer's law is obeyed. The three acids, which possess similar constitutions, exhibit analogous absorption spectra. Benzyl alcohol absorbs quite differently from these acids and, like phenol and benzil, shows only one band. *m*-Bromophenol absorbs similarly to, but far more strongly than phenol, the maximum (2960 Å.) being nearer the less refrangible end of the spectrum than with phenol (2698 Å.). Menthone causes selective absorption owing to the presence of the ketonic group, whereas menthol, and probably saturated cyclic hydrocarbons also, show continuous absorption. Quinoline and pyridine exhibit highly complicated spectra, the former having four and the latter three bands; the intensity of the absorption is similar in the two cases.

T. H. P.

2503. Cr, Mn, Fe, Co, Ni, Cu used as Diffraction Network for corresponding X-Rays. S. Pastorello. *N. Cimento,* 6. *pp.* 50–59, *Feb.,* 1929.

Continues and extends previous work [see Abstract 838 (1929)], taking in chromium and manganese. A. D.

2504. X-Ray Diffraction Haloes in Aqueous Solutions of Electrolytes. H. Shiba and T. Watanabe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 183. *pp.* 187–192, *March* 20, 1929. *In English.*

The X-ray diffraction was observed with the aqueous solutions of H_2SO_4; the hydroxides of Li, Na, K and NH_4; the chlorides and nitrates of Li, Na, K, Be and Al; and the chlorides of NH_4 and Mg. From the results obtained in concentrated solutions they may be classified into three groups: (1) those whose halo has practically the same size of water, as KCl; (2) those the halo of which contracts, as $AlCl_3$; and (3) those the halo of which expands, as NaOH. The halo contraction, as seen in the second group, seemed to be closely related to the formation of aquo-complex of the cations. In general the diffraction at small angles is remarkable in dilute solutions and becomes weak as the concentration is increased. AUTHORS.

2505. Photoelectric Effect and the Continuous X-Ray Spectrum. E. Sevin. *Comptes Rendus*, 188. *pp.* 911–912, *March* 25, 1929.

Treats the photoelectric effect and the continuous X-ray spectrum mathematically, on the lines of the author's recent paper on absolute time and space of four dimensions. Derives formulæ for both cases which agree with experimental results. H. N. A.

2506. Compton's Phenomenon and its Inverse. E. Sevin. *Comptes Rendus*, 188. *pp.* 986–988, *April* 8, 1929.

In a previous paper [see preceding Abstract] the author has expressed by purely undulatory means, and without recourse to quanta, the mechanism of the diffusion of X-rays without change of frequency, the photoelectric effect and the continuous spectrum. He now shows that when a radiation X of frequency ν' meets a free electron it excites a vibration with respect to the ether of frequency $N = 1/\tau = 1{\cdot}23 \times 10^{20}/\sqrt{1 - \nu^2/c^2}$, and that a stable state will be established where the electron absorbs and diffuses energy in a regular manner and takes up a speed ν in the direction of the radiation. From these considerations Compton's phenomena is shown to be an immediate result. The inverse phenomena is then deduced, in which a flux of electrons produces radiation. H. H. Ho.

2507. Release of Photoelectrons by Röntgen Rays from Metal Mirrors at the Limits of Total Reflection. W. Ehrenberg and F. Jentzsch. *Zeits f. Physik*, 54. 3–4. *pp.* 227–235, 1929.

Experiments are described which show that the total reflection of Röntgen rays can be investigated by means of the reciprocal phenomenon, the non-entrance of the radiation energy into the material composing the reflecting surface, and certainly also by means of the photoelectric current. Near the limiting angle of total reflection the photoelectric current reaches a maximum; beyond this angle the current falls very rapidly to an extremely small value. Calculations from the Drude-Lorentz dispersion theory gave results in close agreement with the observed values of the angles of total reflection for silver, gold and steel. A. W.

RADIOACTIVITY.

2508. Groupings of Atoms in the Radio Elements. (Miss) C. Chamié. *J. de Physique et le Radium*, 10. *pp.* 44–48, *Jan.*, 1929.

On studying by the photographic method the distribution of the radio elements in mercury, in different liquids, in the air and on activated surfaces, the existence of groupings of atoms of the radio elements in these media is shown. This has been verified not only for polonium, radiothorium and the active deposits of the three families, but also for radium emanation. Some microphotographs are given in support of the observations. The experiments carried out indicate certain properties of the groupings and show that the phenomenon is very frequent. J. J. S.

2509. Active Volume of the Geiger Point Counter. S. Shirai. *Phys. Math. Soc., Japan, Proc.* 2. *pp.* 12–16, *Jan.-Feb.*, 1929.

Experiments with a Geiger counter are described in which the exciting α-particle beam was applied at different parts of the chamber. Measurements were made both with positive and with negative voltages of the chamber walls, the active volume being more sharply defined in the former case. By systematic exploration it was shown that the active volume for the chamber used (brass tube 2 cm. diameter, platinum point, walls at + 1700 volts) took the form of a cone with vertex at the point of the needle and base at the front wall of the chamber. W. S. S.

2510. Geiger and Müller's Electron Counting Tube. H. Kniepkamp. *Phys. Zeits.* 30. *pp.* 237–238, *April* 15, 1929.

The experiments of Geiger and Müller are in many ways similar to those of Hess and Lawson, v. Beyer and Kutzner, and of the author. All these used glow-lamps with differently formed electrodes, and Geiger and Müller's apparatus is in reality a glow-lamp with a special form for the electrodes. The discharge circuit is nearly the same as the author's. New experiments are described, in which apparatus like that of G. & M. was employed; it was found that results could be obtained with clean wire for the anode, provided that the resistance in series with the tube was chosen rightly, while G. & M. only got results with a wire coated with a badly conducting layer. No reason can be assigned for the discrepancy. H. N. A.

2511. Volatilisation of Polonium. P. Bonét-Maury. *Ann. de Physique*, 11. *pp.* 253–341, *March*, 1929.

It is shown experimentally that there is no definite temperature of vaporisation for polonium. The polonium sources employed were deposited on specially prepared strips of nickel, and in a few cases of platinum, by an electrochemical process or by condensation. The thickness of the film was not greater than the diameter of a polonium atom. It was found that, in a vacuum, the atoms were sent out from the minute circular plane surface covered with polonium used as source according to Lambert's cosine law. The certainty of the test depended on the possibility of measuring minute traces of polonium by means of its radioactive properties. When the quantity vaporised was measured as a function of the time irregularities were found, which appear to be due to the fact that the different sources used are formed by a mixture, in variable proportion, of polonium atoms which are bound with varying forces to the supporting foil. The effect of the speed of heating was also investigated. It appears that vaporisation is opposed by thermal diffusion into the metal of the support. Sources prepared by condensation from gaseous polonium give less regular results than those prepared by electrochemical deposition. More work is required to remove a polonium atom from a platinum surface than is needed in the case of nickel. H. N. A.

2512. Penetration of Polonium into Lead. (Miss) E. Montel. *J. de Physique et le Radium*, 10. *pp.* 78–80, *Feb.*, 1929.

A deposit of polonium was formed on one face of a thin lead sheet by deposition from a slightly acid solution. It was then found that after a period varying from a few days to a few weeks, depending on the thickness of the lead and the activity of the deposit, a photographic impression could be obtained by pressing the sensitive surface of the plate against the other face of the lead sheet, giving an exposure of from 18 hours to 5 days. The impression obtained took the form of a fine network which corresponded in general shape to the image obtained by a direct photograph of polonium deposit. By repeating the experiments with lead sheets consisting of large crystals which occupied the whole thickness of the sheet over a considerable area, it was established that the network followed the contours of the crystals. Thus polonium diffuses through thin sheets of lead by way of the interstices between the crystals. The lead sheets were shown to be impervious to the passage of light or gases. W. S. S.

2513. Quantum Mechanics of Radioactivity. J. Kudar. *Zeits. f. Physik*, 54. 3–4. *pp.* 297–299, 1929.

Commenting on his previous treatment of the problem [see Abstracts 1894 and 1895 (1929)], the author draws attention to the fact that the wave function product $\psi\bar{\psi}$ is no longer integrable since ψ increases exponentially at great distances. It is suggested that the usual space integral be replaced here by the limit: $\lim_{t \to \infty} \int_0^{R = vt} \psi\bar{\psi}\, dV$, where v is the velocity of the expelled α-particle, dV is the volume element and R is the radius of the sphere throughout which the integral is taken. This limit equals $4\pi v/\lambda$, where λ is the disintegration constant. The paper also contains a suggestion as to the mechanism of emission of α-particles of abnormally high velocities. W. S. S.

2514. Quantum Mechanics of the Atom Nucleus (Preliminary Communication). T. Sexl. *Zeits. f. Physik*, 54. 5–6. *pp.* 445–448, 1929.

The quantum theory explanation of radioactive α-particle expulsion is developed, assuming the Coulomb repulsion potential valid up to a distance r_0, the potential dropping discontinuously at this distance to a value constant throughout the sphere $r < r_0$. The general form of solution for the disintegration constant is derived, the numerical computation being postponed. Kudar's treatment [see Abstract 1894 (1929)] is criticised on the ground that Schrödinger's natural boundary conditions are not obeyed; Laue's correct analysis applies only to a plane parallel right-angled potential wall which is a much less close approximation to the actual circumstances than that given in the present paper. W. S. S.

2515. Counting α-Particles. (Miss) M. Desmet and (Miss) M. van Haeperen. *Ann. Soc. Sci. de Bruxelles*, 48. *pp.* 100–113, *Dec.*, 1928.

Compares results obtained by the scintillation method with those using the Wulf counting apparatus, with gramophone needles for " points " and much higher potentials than those used for the Geiger point counter. The behaviour of the Wulf counter was studied with sharp and blunt needles, charged positively and negatively; and curves are given showing the relation between the number of sounds per minute in the telephone and the voltage, with the standard preparation used as the α-ray source. In certain cases this number remained constant over a long range of voltage, giving a horizontal step in the curve. The number of sounds in the telephone was in all cases considerably smaller than the number of scintillations produced by the preparation on a phosphorescent screen, which were counted with considerable accuracy and constancy. H. N. A.

2516. Straggling of α-Particles from Polonium in Passing through Glass. H. Eyring. *Phys. Rev.* 33. *pp.* 386–388, *March*, 1929.

The straggling coefficients for α-particles from polonium in nine gases have been determined from the ends of the Bragg ionisation curves. The value for air of 0·61 mm. checks closely with that obtained by other methods. The values for polyatomic gases are greater than the theoretical values. AUTHOR.

2517. Measurement of the Energy of the β- and γ-Radiations of Radium in the Form of Heat. (Miss) A. Dorabialska. *Acad. Polonaise Sci. et Lettres, Bull.* 9–10*a*. *pp.* 459–470, *Nov.-Dec.*, 1928. *In French.*

The measurements were made by means of the adiabatic microcalorimeter described by W. Świetoslawski and the authoress. The internal calorimeter consisted of a metal cylinder, divided into two parts in such a way that the absorption of the calorific system could be changed, making it possible to separate by calculation the heat due to absorption of the β-and γ-rays from that due to absorption of the α-rays. The experiments indicated that the heat due to the β-radiation of radium and its descendants is 9·1 % of that due to the α-rays, while that due to the γ-rays is 12·4 %. The results obtained agree fairly well with those arrived at theoretically by Miss L. Meitner. H. N. A.

2518. Waves Associated with β-Rays and Relation between Free Electrons and their Waves. G. P. Thomson. *Phil. Mag.* 7. *pp.* 405–417, *Feb.*, 1929.

The variation of the speed of the electrons in the continuous β-ray spectrum is regarded as due to the dispersion of a short-wave group associated with each ray. The mean velocity is about that to be expected if the group had the form of an error function of sufficient spread to give the observed range of velocity. The possibility of a group in the form of a heavily damped wave is considered, and an experiment described concerning the propagation of waves along a thin lath. An expression is considered for the velocity of an electron associated with a given wave, and it is shown to give consistent results in this problem leading to the consequence that the velocity of an electron may vary even in force-free space and explaining Ellis and Wooster's experiment on the heat generated in the disintegration of RaE. This variation of velocity is essentially associated with a short-wave train. H. H. Ho.

2519. Angular Distribution of Compton Recoil Electrons. D. Skobeltzyn. *Nature.* 123, *pp.* 411–412, *March* 16, 1929.

A table gives the angular distribution of 1000 β-ray tracks observed in a gas under the action of a narrow beam of γ-rays with the values calculated for the numbers to be expected between different values of the recoil angle, 0° – 10°, 10° – 20°, etc., according to the theories of Klein and Nishina, Compton, and Dirac and Gordon. The results are plotted in a graph which shows that they agree much better with the Klein-Nishina theory than with that of Dirac and Gordon. The discrepancies, however, in the former case exceed the probable statistical deviations, and cannot be attributed to experimental errors only. A detailed paper will shortly be published. H. N. A.

2520. Temperature Coefficient of γ-Ray Absorption. L. Bastings. *Phil. Mag.* 7. *pp.* 337–345, *Feb.*, 1929.

Measurements were made with lead, iron, tin and aluminium. An electric furnace was used, consisting of a quartz cylinder wound with nichrome strip and lagged, so that very little heat passed out to the electrometer, which was also thermally insulated. The correction for the expansion of the metal is considered, and the calculated values of β, the temperature coefficient of the absorption constant, assumed linear over the range of temperature employed, are tabulated. The value of β in each case falls very close to the value of a, the coefficient of linear expansion of the metal, so that the atomic absorption appears to be nearly, if not exactly, a function of the linear distance between the atoms of the absorber. H. N. A.

2521. Penetrating Radiations. E. Rutherford. *Engineer,* 147. *p.* 413, *April* 12, 1929. *Paper read before the Roy. Inst.*

A general account of the ultra-penetrating "cosmic" rays and their absorption by matter. A number of experiments were shown, and a new method devised by H. Geiger for detecting and counting the individual recoil electrons produced by the penetrating radiations was shown in operation. H. N. A.

2522. Double Camera for Photographing Artificial Disintegrations. P. M. S. Blackett. *Roy. Soc., Proc.* 123. *pp.* 613–629, *April* 6, 1929.

The arrangement recommended has the two plates at right angles, but the lenses tilted so that the plane of the Wilson chamber is conjugate with both plates. To effect this the principal plane of both lenses is made to pass through the line of intersection of the plane of the chamber with the plane of the plate. The lens axis is inclined only 8°27′ to the normal to the plate. The relations between depth of focus, intensity of image and magnification are discussed; the last should be as small as possible (1/5 is adopted), but is limited by the resolving power of the emulsion. The optimum number of tracks and the advantages of reduction of pressure and dilution of the gas are discussed in detail. C. A. S.

HEAT.

2523. Survey of Heat Conduction Problems. E. Griffiths. *Phys. Soc., Proc.* 41. *pp.* 151–174; *Disc.*, 174–179, *Feb.*, 1929.

Deals with practical methods for the determination of the thermal conductivity of (*a*) non-metallic substances of very low thermal conductivity of the order of 0·0001 c.g.s., such as are used for "cold storage" insulation; (*b*) non-metallic substances in thin sheets of medium thermal conductivity; (*c*) refractories and materials used for heat insulation at high temperatures; and (*d*) metals and alloys. The insulating value of materials in class (*a*) is due to the fact that they subdivide the air space into a large number of very small air cells. A sample of baked slab cork has been found with a thermal conductivity as low as 0·00007 c.g.s., that of still air being 0·00006. The theory of heat conduction through granular material, as worked out by Smoluchowsky and others, diverges widely from the results obtained by experiment. In the testing of materials of low thermal conductivity it is important to eliminate the effect of heat leakage from ends and corners, as, for example, by the use of a guard plate. Descriptions and sketches are given of suitable forms of apparatus for the measurement of the thermal conductivity of the various classes of materials mentioned above. Measurements have also been made, in the case of some metals and alloys, of the electrical conductivity (λ), and it has been found that for aluminium alloys and bronzes the values of the Lorenz coefficient ($K/\lambda T$) approximate to the values for the pure metals, *viz.*, 5·5 for the Al alloys and 5·9 for the Cu alloys. T. B.

2524. Temperature Control Apparatus. L. A. Richards. *J.O.S.A. & R.S.I.* 18. *pp.* 131–137, *Feb.*, 1929.

Describes the construction of a constant temperature air bath, which is easily constructed. The original paper should be consulted for details. E. G.

2525. Specific Heats of Acetone, Methyl-, Ethyl-, and *n*-Propyl-Alcohols at Low Temperatures. S. Mitsukuri and K. Hara. *Chem. Soc. Japan, Bull.* 4. 4. *pp.* 77–81, *March*, 1929.

In view of the difficulty of maintaining a constant temperature of environment in calorimetric determinations at low temperatures, a method is described in which the observations are made with the calorimeter in an environment the temperature of which is rising regularly. The determinations cover the following ranges of absolute temperatures: acetone 204°–256°, methyl alcohol 190°–265°, ethyl alcohol 184°–269°, *n*-propyl alcohol 162°–274°. A. J. M.

2526. Liquefaction Temperatures by Electrical Conductance Method. E. W. Washburn and E. R. Smith. *Bureau of Standards, J. of Research*, 2. *pp.* 787–791, *April*, 1929.

The method is applicable to a substance which is a non-conductor when solid but becomes a conductor as soon as the liquid phase appears. It is specially useful where only a few milligrams of material are available. A platinum electrode is sealed into a glass tube, which projects through the base of an iron cell. For the determination of the eutectic temperature in an aqueous system the cell is partly filled with water, which is then frozen so that the end of the platinum projects through the surface of the ice. A few milligrams of the powdered substances are placed round the electrode, and the cell immersed, with a thermometer, in a mercury bath. The cell is placed in series with the heating element of a vacuum thermocouple and a potential of 6 volts applied, the thermocouple leads being connected to a galvanometer. The temperature of the bath is gradually raised and the point observed where a deflection of the galvanometer occurs. Eutectic and transition temperatures have been determined, with a deviation of 0·01° C. to 0·07° C. from accepted values. A. J. M.

2527. Boiling Points in Homologous Series. B. Nekrassow. *Zeits. f. phys. Chem.* 140. *Abt. A.* 5–6. *pp.* 342–354, *Feb.*, 1929.

Consideration of the functional dependence of the boiling point on the molecular mass and volume leads to the following empirical formula, which represents the boiling points in a homologous series by a constant: $T_s\frac{\sqrt{R}}{\sqrt{M}(1-R)}$ = a constant, M being the molecular weight, R the specific refraction (proportional to the true volume of the molecule of a mass-unit of the substance), 1 — R a magnitude proportional to the free space in a mass-unit, and T_s the boiling point. In order to facilitate calculation, this formula may be converted into the form: $T_s\frac{\sqrt{MR}}{M-MR}$ = a constant, MR being the molecular refraction (Lorenz and Lorentz). In the simplest case, that of the normal saturated hydrocarbons, the specific refraction is calculated directly from the optical data. In most cases, for polar compounds, an empirical magnitude differing numerically from the optical equivalent, must be introduced for the polar groups. The possible physical interpretation of this difference is discussed. For the normal saturated hydrocarbons the validity of the boiling-point formula at diminished pressures is established, and a formula is derived which remains valid to the critical temperatures and expresses fairly accurately the magnitudes of the differences of the vapour pressures occurring on passage from one member of a homologous series to the next. T. H. P.

2528. Gas State in Substances of Low Boiling Point. K. Wohl. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 77–114, *Jan.*, 1929.

This paper is a continuation of an earlier one by the same author [see Abstract 2436 (1928)], and deals with the comparison of the data of condition of state of low boiling-point substances with one another and with those of normal substances. This leads to conclusions with regard to the magnitude of van der Waals constants *a* and *b* and their dependence on temperature. It also leads to inferences on the effect of zero-point energy on the equation of state and shows that the molecular models of the older quantum theories do not afford a suitable basis for a quantitative study of van der Waal's forces. The paper contains tables of the critical constants of the inert gases as well as those of H_2, N_2, O_2 and CO_2. Tables of the second virial-coefficient, *i.e.*, the value of b in the equation $pv = RT + bp$, are also given. The results are discussed and deductions are made; these latter dealing with (1) the law of force, (2) the co-volume at absolute zero, and (3) zero-point energy. T. B.

2529. Diagrams and Nomograms. J. H. Coblyn. *Comptes Rendus*, 188. *pp.* 898–900, *March* 25, 1929.

It is usual in thermodynamic calculations to employ the equation of state, $pv = RT$, combined with the equation $pv^{C/c}$ = const. for an adiabatic expansion, or pv^n = const. for any expansion whatever, n being supposed constant. A slide rule or tables of logarithms is then sufficient for approximate calculation. Unfortunately these approximations are not close enough when a slightly superheated vapour is being dealt with. It is preferable in this case to use nomograms, this being possible because of the peculiarity that for all fluids the equation of state is practically a linear equation in T and p, namely, $Ap = V_1'T - V_2'$, V_1' and V_2' being functions of volume and A the heat equivalent of the unit of work. For example, entropy (S) and internal specific energy (U) are easily expressed in the equations $MS = T_1' + V_1$ and $MU = (T_1'T - T_1) + V_2$, where T_1 is a function of T only. T. B.

2530. Evaporation of Thorium from Tungsten. Mary R. Andrews. *Phys. Rev.* 33. *pp.* 454–458, *March*, 1929.

The rate of evaporation of thorium from pure tungsten and from carbonised tungsten was measured between 2000° and 2500° K. The thorium was deposited on these surfaces by evaporation either from thoriated filaments or from metallic thorium. Evaporation from both surfaces was found to vary directly with the fraction covered, being more rapid from pure tungsten than from carbonised tungsten. Heat of evaporation from tungsten was calculated to be 177,000 cal. gm.-atom and from carbide 202,000 cal. AUTHOR.

2531. Attempts to Determine Differences between the Vapour Pressure of Isotopes by Fractional Distillation. Part I. H. G. Grimm. Part II. H. G. Grimm and L. Braun. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 181–206, *Feb.*, 1929.

In Part I CCl_4 was investigated. The method employed and the difficulties encountered are described; the final result was that no difference of density could be found between the different fractions obtained which exceeded the probable error of measurement of about 2×10^{-5}. The author calculates that the difference of boiling point between two kinds of CCl_4 whose molecular weights differ by two units cannot be larger than 10^{-3} degrees; it was assumed that the vapour pressure curve of mixtures of isotopes has neither maxima nor minima. It should be noted that five different kinds of CCl_4 molecules are to be expected, CCl^{37}_4, $CCl^{37}_3 Cl^{35}$, $CCl^{37}_2 Cl^{35}_2$, $CCl^{37} Cl^{35}_3$, CCl^{35}_4. The result obtained indicates the existence of zero point energy in this compound. Part II deals with the distillation of 60 tons of liquid chlorine, carried out by the Badische Anilin-und Soda-Fabrik. The fractions were converted into NH_4Cl, and the density of saturated solutions of these salts were determined with a torsion balance. No difference in density was found. The ratio between the isotopes in ordinary chlorine is 77 : 23, and this cannot have been altered as much as to 77·04 : 22·96. Any alteration in atomic weight must have been less than 0·0008 unit of atomic weight. H. N. A.

2532. Theory of the Transmission of Heat by Convection. D. Graffi. *Accad. Lincei, Atti,* 8. *pp.* 573–575, *Dec.* 2, 1928.

A mathematical treatment of the transmission of heat by convection. J. J. S.

2533. Theory of the Radiometer. P. S. Epstein. *Zeits. f. Physik,* 54. 7–8. *pp.* 537–563, 1929.

The problem of the axially symmetrical viscous flow of a gas past an oblate ellipsoid is solved in general form, quadratic terms being neglected. The radiometer force acting upon a thin plate of elliptic profile is deduced. Two cases are to be distinguished: (1) in the case of plates of low thermal conductivity, Einstein's formula holds and the force is proportional to the radius and independent of the thickness of the plate; (2) for good conductors the converse is the case, the radiometer force being then proportional to the thickness of the plate and independent of its radius.

J. S. G. T.

2534. Supposed Limitation of the Second Law of Thermodynamics. C. Coolman. *Phil. Mag.* 7. *pp.* 504–507, *March*, 1929.

An experimental test of the statements of Gaede and Kossonogov. In the centre of a large bolt-head flask a system was suspended on a quartz thread consisting of a little rod with a mirror, at the ends of which are attached two thin porous plates with conical apertures. The porous plates were attached in such a manner that the narrow ends of the conical pores of the one plate were turned in the opposite direction to the narrower ends of the pores in the other. If a greater quantity of molecules flowed through these pores in one direction than in the other, a rotational movement would be imparted. The apparatus was thermally insulated, and three series of observations taken. The results showed that with a good constancy of zero in limits from 10^{-7} to 760 mm. Hg pressure a complete absence of the effect ensued. The same results were obtained with little diaphragm-like wings made of porous plates similar to those of Kossonogov (gypsum and cement). Evidently the directing action of the surface film inferred by Gaede (if it exists) in this case cannot lead to a limitation of the second law because of the unevenness of the surface, and perhaps the oscillations of the surface film itself. The limitations pointed out by Gaede and Kossonogov must be considered as both theoretically and experimentally inconsistent. S. G. B.

2535. Thermodynamics of Mixtures. V. Fischer. *Zeits. f. Physik*, 53. 1–2. *pp.* 138–147, 1929.

A theoretical discussion on the thermodynamics of mixtures relating to their heat of fusion and vaporisation. The relationship between these factors and the corresponding quantities for pure materials of the mixture is derived. The general form of the expression for the equilibrium conditions of such mixtures is deduced, and use is made of the potential equation for mercury. S. G. B.

2536. Lessening of Entropy in a Thermodynamic System by Interference of an Intelligent Being. L. Szilard. *Zeits. f. Physik*, 53. 11–12. *pp.* 840–856, 1929.

The question is discussed in what circumstances and under what conditions an apparent construction of a system with perpetual motion may be made if a being possessing an intellect is permitted to interfere in a thermodynamic system. J. J. S.

2537. Maxwell-Clausius and Clapeyron Relations. V. Karpen. *Comptes Rendus*, 188. *pp.* 778–779, *March* 11, 1929.

This is a generalisation of a previous investigation [see Abstract 1608 (1929)], in which the Maxwell-Clausius and Clapeyron formulæ were deduced from van der Waals' equation. In this discussion Carnot's principle is not assumed, but is replaced by the condition that a liquid and its saturated vapour should be in equilibrium. F. S.

SOUND.

2538. Transmission of Sound through Sea Water. J. H. Service. *Frank. Inst., J.* 206. *pp.* 779–807, *Dec.*, 1928.

The paper deals primarily with a comparison of the velocities of sound in sea water as determined by various authorities by direct experiment or by computation from elasticity and density data. In particular the author compares his own calculations of velocity at various temperatures, salinities and depths with those of the British Admiralty. The values of the latter authority were determined experimentally by Wood, Browne and Cochrane [see Abstract 1906 (1923)], and tabulated data of calculated values were prepared by D. J. Mathews. Reference is made to German observations at various depths in the Atlantic with a corresponding series by Heck and Service (*Science*, 64. p. 637, Dec., 1926)—using in both cases the echo-sounding method. The paper concludes with certain observations relative to the radio-acoustic method of position-finding and to the transmission of sound through materials under water. A. B. W.

2539. Compressibility and Sound Velocity for some Organic Liquids. E. B. Freyer, J. C. Hubbard and D. H. Andrews. *Am. Chem. Soc., J.* 51. *pp.* 759–770, *March*, 1929.

Apparatus consisting of a high-frequency electrical oscillator, a controlling fixed-frequency oscillator and a "sonic interferometer" for producing and determining the wave-length of sound waves is described. The velocity of sound in and the isothermal compressibility of the following liquids are given: benzene, acetone, ethyl alcohol, methyl alcohol, chlorobenzene, toluene, chloroform, ether, carbon tetrachloride and carbon bisulphide. The velocity of sound in and the adiabatic compressibility of heptane, octane, aniline, α-bromonaphthalene, glycerin, bromoform and the isomeric heptanes are also given. W. H. Ge.

2540. Velocity Measurements with Heated Wires in Stationary Air-Waves. G. Goldbaum and E. Waetzmann. *Zeits. f. Physik*, 54. 3–4. *pp.* 179–189, 1929.

An extension of a previous research [see Abstract 174 (1925)]. By means of an arrangement similar to that employed before, the relative periodic and constant cooling effects on a heated wire placed in a tube in which stationary waves are maintained, are measured. For the purpose of determining the sound intensity and the speed amplitude a measurement is also made of the constant cooling effect in a steady current of air. G. E. A.

2541. Theory of Hearing. G. v. Békésy. *Phys. Zeits.* 30. *pp.* 115–125, *March* 1, 1929.

Special apparatus was developed to investigate fatigue effects in the human ear. Experiments showed that the apparent loudness of a constant sound could be appreciably reduced owing to fatigue. The variation of this effect in different individuals and its dependence on frequency and amplitude were investigated. It was found that the variations of loudness of a pure tone due to the tympanum are small, so that the fatigue phenomena are concerned solely with the susceptibility of the basilar membrane. This is discussed in its bearing on various theories of hearing. By increasing the outer air pressure the tension of the tympanum could be increased and investigated; it was found that such tension could not completely explain the existence in the ear of combination tones. It appears probable that the latter are principally due to rectification effects in the cochlea. A. W.

2542. Objective Characteristic of Stringed Instruments. A. Seiffert. *Zeits. f. Instrumentenk.* 49. *pp.* 116–129, *March*, 1929.

The author first discusses the present uncertain mode of appraising an instrument. An outline of the mechanical theory of the violin is given, and the physical factors on which the acoustic output of a violin depends are detailed. An apparatus is then described by which a violin may be subjected to a series of physical tests. The violin is clamped upright in a rigid framework, and a bridge which spans the violin carries a mirror-holder, the end of which, bearing a small mirror, is applied to a point on the breast or back of the instrument. The indicator of the vibrations consists of the mirror on the end of a 1-cm. lever hinged to the holder. Behind the mirror is a drawing-pin, the point of which rests on a cover-glass stuck on a small piece of wood attached to the violin with plasticine. The motion of the violin is communicated to the mirror, and by interposing a fixed mirror a spot of light can be read on a scale above or beside the violin, so that one observer can bow the string and take the readings. Two instruments were tested which had been made for the purpose on Stradivarius and Guarnerius models. The breast and back were mapped out into a series of 84 points and explored by the mirror. Tables are given of the effects caused by gradual application of tension to the strings, and of the different amplitudes of vibration at the specified points. Nodal lines are obtained for breast and back; on either side of these the bending is in opposite directions. It is considered that the method will provide information, in the form of charts of vibration amplitudes and nodal lines, which will characterise any given instrument and enable a definite judgment to be formed as to its quality, defects and value. G. E. A.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

2543. Structure of an Electron. Part II. U. Kakinuma. *Phys. Math. Soc. Japan, Proc.* 2. *pp.* 1–11, *Jan.–Feb.*, 1929.

The general theory given earlier [see Abstract 2253 (1929)] is applied to the case of an electron. It is assumed that the mass of the electron can be attributed entirely to the electromagnetic field. The electron is given spherical symmetry. Despite simplifying assumptions a consistent scheme is not obtainable. Possibly axial symmetry (spinning electron) is indicated. W. S. S.

2544. Translation of Dirac's Theory of the Electron into a Familiar Form. E. Madelung. *Zeits. f. Physik*, 54. 5–6. *pp.* 303–306, 1929.

A system of four equations, two scalar and two vector (three-dimensional), is laid down for four quantities σ, τ, scalars and S, T, vectors. The equations are of the first order and imply that σ, τ, and the components of S, T, each satisfy in the absence of an electromagnetic field the relativistic wave equation $\left(\text{div. grad.} - \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \frac{4\pi^2 c^2 m^2}{h^2}\right)\psi = 0$. For a central symmetric static field of force, the eight equations reduce to Dirac's four-wave equations. The significance of the present system, apart from the use of familiar vector notation, is the analogy with the Maxwellian equations of electrodynamics. W. S. S.

2545. Distribution of Charge and Current in an Atom consisting of many Electrons obeying Dirac's Equations. D. R. Hartree. *Cambridge Phil. Soc., Proc.* 25. *pp.* 225–236, *April*, 1929.

Each electron is regarded as moving in a stationary central field due to the nucleus and the remaining electrons. To this approximation it is shown that, using Schrödinger's equation, a complete *n*, *l*, group of electrons (2 $(2l + 1)$ electrons with the same *n*, *l*, but variable *m* and spin direction) splits into two half-groups ($\overline{2l + 1}$ electrons with the same spin direction), for each of which the total charge distribution is spherically symmetrical. Using Dirac's theory it is shown that a complete Stoner sub-group $\{\overline{2j + 1}$ electrons with the same *n*, *l*, *j* $(j = l \pm \frac{1}{2})\}$ splits into two halves, for each of which the change is spherically symmetrical. Thus a many-electron atom is spherically symmetrical to a higher degree in Dirac's than in Schrödinger's theory. It is further shown, using Dirac's equations, that for a complete Stoner sub-group the net current and magnetic moment is zero. The question whether it is possible to specify the direction of the magnetic moment of the electron as distinct from that of the whole atom is investigated, and it seems justifiable to do so for states in which the magnetic quantum number *m* has its extreme values $\pm j$, but not otherwise. The Landé *g*-formula for one electron is derived from the formula for the magnetic moment by neglecting relativity terms. W. S. S.

2546. Electrodynamics: Modern Development of Classical Theory. R. Ferrier. *R.G.E.* 25. *pp.* 635–644, *April* 27; 677–682, *May* 4, *and pp.* 715–721, *May* 11, 1929.

Classical electrodynamic theory is developed and brief reference made to difficulties necessitating the development of modern theory. J. S. G. T.

2547. Electrons and Quanta. C. J. Davisson. *J.O.S.A. and R.S.I.* 18. *pp.* 193–201, *March*, 1929. *Bell System Techn., J.* 8. *pp.* 217–224, *April*, 1929.

The experiments by the author and L. H. Germer, by G. P. Thomson and by others, from which the wave properties of electrons are adduced, are briefly described. The agreement between the results of these experiments and the prediction of L. de Broglie is pointed out. The wave and corpuscular properties of electrons are compared with the similar properties of light quanta. AUTHOR.

2548. Eddington's Hypothesis and the Electronic Charge. E. Bäcklin. *Nature*, 123. *pp.* 409–410, *March* 16, 1929.

With reference to Eddington's recent paper [see Abstract 1613 [1929)] the author reviews the values of e obtained by Millikan, by Wadlund and by himself, and comes to the conclusion that in neither case is the degree of accuracy sufficient to make it possible to decide between the published values and that required to give the value of 136 for $hc/2\pi e^2$ which results from Eddington's theory. It is to be remembered also that h is not known with the same accuracy as e. H. N. A.

2549. Triboelectricity. V. Polara. *N. Cimento*, 6. *pp.* 78–83, *Feb.*, 1929.

Dilute zinc amalgam becomes negatively charged against glass when the temperature is not above 70°–80° C. Fresh potassium amalgam appears non-excitable at low temperatures, but becomes negatively charged if the temperature rises, the negative charge being at its greatest at 50°–70° C. Potassium amalgam more than two hours old appears unexcitable at ordinary temperatures, but becomes positively chargeable if warmed to 30°–40°C. A. D.

2550. Theory of Electrostatic Machines. H. Chaumat. *Comptes Rendus*, 188. *pp.* 1096–1098, *April* 22, 1929.

The possibility of constructing an electrostatic machine in which the capacity is made to vary, and depending on the application of the equations $W = Q^2/2C$ and $Q = CV$ is mooted. C. A. S.

2551. Electrical Conductivity of the Air and the Earth's Electric Field at and near Ground Level by means of the Wilson Universal Electrometer. R. E. Watson. *Meteorolog. Office, Geophys. Mem. No.* 45 [23 *pp.*], 1929.

The author gives the results of a series of experiments made at Kew. It is found that the effective conductivity of the air at a height of 130 cm. compared with that at ground level depends upon the meteorological state of the atmosphere. The presence of an observer and instrument increases the normal undisturbed electric field about six times. During varying atmospheric conditions involving changes in the ionic content of the air the electric field changes lag behind the conductivity changes. Applying corrections now established the air-earth current at Kew is $0{\cdot}94 \times 10^{-16}$ ampere/cm.^{2} with a variation of $\pm 15\,\%$. It is considered that the Wilson electrometer measures the conductivity due only to the positive ions, and the considerably larger values of the air-earth current found at Göttingen, Potsdam and Davos apply to measurements of both positive and negative ions. With this assumption the Kew figures agree much more nearly with those at other places. R. S. R.

2552. Contribution to the Study of Fulminating Matter ; Its Two Modes of Decomposition. E. Mathias. *Comptes Rendus,* 188. *pp.* 1132–1134, *April* 29, 1929.

Quoting from various descriptions of " ball lightning," in which there is sometimes record of a violent explosion, and in others of a calm dissipation only, the author concludes that the " fulminating matter " commences by decomposing quietly, but where there is sufficient, it ends by exploding violently. W. G. B.

DISCHARGE AND OSCILLATIONS.

2553. Form and Structure of Sparks. Part V. Long Sparks in Different Gases. T. Terada, U. Nakaya and R. Yamamoto. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 177. *pp.* 43–68, *Feb.* 14, 1929. *In English.*

This paper, which is very well illustrated with photographs, extends the results previously published [see Abstract 2459 (1928)]. A new apparatus has been developed which is suitable for pressures above and below atmospheric. Sparks under various circuit conditions were examined at normal and reduced pressure in SO_2, C_2H_2, CO_2, O_2, N_2, air and coal gas. For SO_2 the photographs of the sparks in this gas at normal pressure resemble those of wires exploded by heavy currents. A reduction of sulphur also occurs. In reduced pressure the spark approaches in form the long zigzag spark in air at normal pressure. The sparks in C_2H_2 are fibrous in structure with rectangular bending, and are also surrounded by an aureole consisting of an afterglow lasting for 10^{-4} sec. An aureole with afterglow is also observed for the spark in CO_2. The three-part spark is generally observed for the long spark in O_2, and decreasing the pressure increases the length of the positive part and decreases the characteristic sinuosity. By fitting needle leakage points to either electrode for air at decreasing pressures the form of the spark gradually changes from the zigzag to the smooth curvilinear type, but the three-part spark is not obtained. With a water resistance in the circuit the three-part character is shown by the long spark in air, and is accompanied by an aureole of afterglow. In C_2H_2, CO_2 and coal gas the sparks exhibit a wavy form and fibrous character, with the water resistance in circuit, and are preceded by a fine pilot spark. With a slate resistance in circuit, thus obtaining an even higher resistance, a variety of types of sparks can be obtained due to changes in property of the slate with continued use, finally leading to a flash-over across the slate and giving rise to a thick spark. It is concluded that the long spark generally has definite stages of formation, with a consequent time of production. The three-part spark is prepared by the building up of the positive part, which also controls the negative part. A fine spark, due to electrode capacity, is first obtained with the high-resistance circuit, paving the way for the main discharge. [See also Abstract 3075 (1928).] R. C. F.

2554. Neon Lamps. V. Ronchi. *N. Cimento,* 6. *pp.* 10–13, *Jan.,* 1929.

Neon lamps glow up when they are not in a circuit, but are exposed to a variable electric field due to movement of electric charges. The sensitiveness of this arrangement for detecting movement of electric charges is sometimes greater than that of any other method. A. D.

2555. Copper Arc. W. B. Nottingham. *Frank. Inst., J.* 207. *pp.* 299–314, *March*, 1929.

The Langmuir probe has been used to explore the copper arc. The kathode fall of the normal arc has been found to be 20·5 volts, which equals the second ionisation potential of Cu(II), while the kathode fall for the hissing arc has been found to be 14·0 volts. The potential gradient along the arc stream is constant, and therefore the space charge is zero and the concentrations of the positive and negative ions are equal. The average energy of electrons throughout the arc is between 2·1 and 2·7 volts.
E. E. F. d'A.

2556. Vacuum Arc Lamp of New Design for Spectroscopic Work. K. Prosad. *Journ. Sci. Instruments*, 6. *pp.* 126–130, *April*, 1929.

This new arc lamp differs mainly from the types hitherto employed in that, by a suitable electromagnetic device, the arc can be struck in vacuum from outside as often as desired and can be run without attention for about an hour or so at a stretch, while the vacuum seal is so simply made that, even if the arc is to be uncovered, the time taken in resealing the cover air-tight is very short. Ordinarily the arc works at a pressure of about 1 cm. of mercury very steadily, but if desired the vacuum can be further lowered. At the same time the mechanical parts are so simple that there is no possibility of anything going out of order. AUTHOR.

2557. Vaporisation at the Kathode in the Mercury Vapour Arc. E. Kobel. *Phys. Zeits.* 30. *pp.* 233–235, *April* 15, 1929.

The results obtained by v. Issendorff [see Abstract 1626 (1929)] show that the whole of the surface of the kathode in the mercury vapour arc is concerned in the vaporisation. Experiments carried out at the research laboratories of the A. G. Brown Boveri et Cie in 1927 led to the conclusion that the quantity of mercury vaporised at the free surface of the kathode of a mercury rectifier constitutes the principal part of the total from the kathode, including the kathode spot. A description of the experiments is given. A. W.

2558. Method of Determining Critical Potentials and its Application to Mercury Vapour. V. Pavlov and N. Sueva. *Zeits. f. Physik*, 54. 3–4. *pp.* 236–245, 1929.

Use is made of the variation of velocity distribution in a beam of electrons, which occurs each time when the electron velocity reaches or slightly exceeds the critical potential sought for, as an indication of collisions at which the whole or nearly the whole energy of the electron is transferred to the atom. The relative number of slow electrons in the electron beam as a function of the accelerating potential V was experimentally determined. The corresponding curve shows a series of maxima whose positions serve to determine the critical potentials. With $V > 4\cdot66$ volts the method gives the previously known critical potentials of mercury vapour and a number of others. Critical potentials were found at 5·25, 5·75, 6·05, 6·30, 7·10, 7·45 and 8·05 volts, for which the corresponding spectral lines are not known. A considerable number of critical potentials was also found in the region between 0·45 and 4·66 volts, which is below the first excitation step of a normal mercury atom. The potentials found were at 0·45, 0·65, 0·95, 1·20, 1·40, 1·65, 1·80, 2·00, 2·25, 2·60, 2·85, 3·10, 3·45, 3·60, 3·85, 4·15 and 4·40 volts. A. W.

2559. Increase of the Sparking Potential of a Gas Mixture by Irradiation. F. M. Penning. *K. Akad. Amsterdam, Proc.* 32. 3. *pp.* 341–343, 1929.

It has been shown previously [see Abstract 1014 (1928)] that, in general, for large values of the product *pd* (*p* = pressure, *d* = distance between electrodes) the sparking potential of neon and argon was much lowered if the ionisation potential of an admixed gas was smaller than the excitation potential of the main gas. To explain this result it was assumed that metastable atoms of the main gas ionise the atoms of the admixture. A proof of the correctness of this explanation was found in the influence of radiation on the sparking potential of such a gas mixture. It is shown that illumination by the light of a neon tube should increase the sparking potential of the gas mixture, neon being the main gas in the discharge tube. This was found to be the case experimentally. The neon tube was bent into a circle round the discharge tube, which was filled with neon at about 20 mm. pressure, argon being present to the amount of about 0·001 %. A current of 15 m. amps through the neon tube caused an increase of 28 volts in the sparking potential, while a current of 100 milliamperes caused an increase of 50 volts. A considerable increase of the sparking potential is only obtained if the amount of admixed gas is small and the pressure of the main gas is not too high. Reasons for this are given. A. W.

2560. High-Frequency Discharges in Gases. J. S. Townsend and W. Nethercot. *Phil. Mag.* 7. *pp.* 600–616, *March*, 1929.

The relation between current and electromotive force has been investigated for high-frequency electrodeless discharges in nitrogen. In general the electromotive force E is given as the sum of two terms in the form $E = X(x + a) + b\lambda I$, where a, b and X are constants, x is the distance between the electrodes, λ is the wave-length and I the current. A theoretical analysis shows that the first term describes the phenomena in the middle of the discharge tube, X representing the electric force parallel to the axis of the tube at points remote from the electrodes. The second term $b\lambda I$ represents an electromotive force in regions near the electrodes where the space charge impedes the current. In a comparison of the discharges with internal and external electrodes it was found that for a given current the potential E is slightly greater with external than with internal electrodes. The difference is attributed to a fall of potential proportional to the current, between the external electrodes and the surface of the tube. Experiments are also described of continuous current discharges in tubes fitted with internal electrodes in the form of sleeves. [See Abstract 1349 (1928).] F. J. W.

2561. High-Frequency Discharges in Helium and Neon. R. L. Hayman. *Phil. Mag.* 7. *pp.* 586–596, *March*, 1929.

The starting and maintenance potentials for high-frequency discharges through helium and neon are determined, the gases, carefully purified, being contained in cylindrical tubes provided with external electrodes in the form of lead sleeves. Differences between the results with helium and neon are of degree only. Distribution of luminosity depends on pressure and the current between electrodes, colour of discharge on pressure and intensity of electric field. Impurities in too small quantity to be easily detected spectroscopically cause marked lowering in starting, little in maintenance potential. Starting potential is a minimum for a certain pressure for each distance between electrodes: decreases as the diameter of the tube increases, variation increasing as pressure decreases; and increases with wave-length at pressures below 6 mm. Maintenance potential varies with current, passing through a minimum value (current being independent of distance between electrodes); is a minimum for a certain low pressure, and then increases linearly with pressure; consists of two parts: the fall in potential along the tube independent of wave-length, and the drop at the electrodes proportional thereto; and lastly increases as the tube is narrower. Ionising radiations falling on the tube have no effect. Stable striations appear under certain conditions (described). C. A. S.

2562. Corona Discharge in Neon. F. M. Penning. *Phil. Mag.* 7. *pp.* 632–633, *March*, 1929.

Reference is made to some experiments by Huxley [see Abstract 1959 (1928)] on the corona discharge in helium and neon. Huxley found that at higher pressures the negative discharge (wire kathode) started at a higher potential difference than the positive. Some experiments by the present author indicate that this effect manifests itself only when the gas is not pure. In pure neon the starting potential is found to be somewhat higher for the positive discharge than for the negative, but the presence of 0·0001 % of argon is sufficient to reverse this effect. T. B.

2563. Electronic and Ionic Currents in Gases at Low Pressures. G. Spiwak. *Zeits. f. Physik*, 53. 11–12. *pp.* 805–839, 1929.

Starting from the electrostatic fundamental equations and the conditions of stability of the gas discharge, the phenomena occurring between two plane electrodes in the presence of an ionised gas are considered (at low pressure, *i.e.*, under 0·001 mm. Hg), in which the ionisation is produced by collisions of electrons which are emitted from a glowing kathode. The influence of the Maxwellian distribution of electron velocity on the degree of ionisation of the gas is investigated. Then the relations are established which give the initial distribution of the charges as function of the potential, as well as the positive ionic current at particular discharge places as function of the potential and the coordinates of the given place for the initial condition and for the stationary discharge condition. Expressions are found which furnish a series of approximate generalisations of the Child-Langmuir law for the case of two charges of opposite sign. The relation of the increase of the thermionic current in the gas to the same in vacuum as function of the pressure and the local potential is calculated. The mean value of this magnitude expresses the "effectiveness" of the positive ion between the plane electrodes. J. J. S.

2564. Measurement of Excitation and Ionisation Potentials by the Diffusion Method. W. Gliwitzky. *Ann. d. Physik*, 1. 6. *pp.* 701–720, *April* 6, 1929.

Experiments on the diffusion method of measuring excitation and ionisation potentials previously described [see Abstracts 1364 and 1365 (1928)] have been continued. The critical potentials of argon were first measured by Hertz's differential method and then by the diffusion method. The latter method was also used for a mixture of helium and neon. The results show that for excitation potentials the diffusion method is as useful and suitable as the differential method. For ionisation potentials the diffusion method is preferable, since well pronounced maxima are obtained, making it possible to obtain the same degree of accuracy in this case as in the case of excitation potentials. A. W.

2565. Theory of Columnar Ionisation. G. Jaffé. *Ann. d. Physik,* 1. 7. *pp.* 977–1008, *April* 19, 1929.

The author some years ago put forward a theory of columnar ionisation [see Abstract 321 (1914)] based on diffusion and recombination, both the latter conforming to normal laws. The theory was incomplete, as it was only applicable to a single columnar discharge, and no account was taken of reciprocal effects between ions derived from different columns. In the present paper the theory is extended to include such effects, and comparison with experimental results shows that the basis of the theory is sound. A. W.

2566. Nature of Ions in Air. H. A. Erikson. *Phys. Rev.* 33. *pp.* 403–411, *March,* 1929.

Results are given showing the production and ageing of the initial positive ion in dried air and dried nitrogen. Results are also given showing that when the final positive air ion of mobility 1·36 is passed into moist air the final ions disappear and a swifter 1·87 ion appears. Results are also given showing that these in turn change back into a 1·36 ion. The interpretation given of the above is that a neutral H_2O molecule gives up an electron to the final 1·36 two-molecule positive ion, thus giving a one-molecule positive ion which has a higher mobility. This H_2O^+ ion ages by attaching itself to another molecule forming a slower 1·36 ion. The article closes with a statement of the reasons for the author's view that the initial and final positive ions are respectively one and two molecules large. AUTHOR.

2567. Mobility Distribution and Rate of Formation of Negative Ions in Air. J. L. Hamshere. *Cambridge Phil. Soc., Proc.* 25. *pp.* 205–218, *April,* 1929.

The investigation was carried out by a modification of Rutherford's alternating field method, ions being produced by α-rays from polonium and driven in by a second alternating field synchronised with the main field. Strength of field, time of complete cycle and pressure were varied and effects of water vapour examined. Current voltage and current frequency curves were traced. No sign of a higher mobility than 2·15 or lower than 1·45 (with peak at 1·8) was found, distribution between these limits being continuous. There is no evidence of any group of ions outside these limits, or to support Laporte's "probability" distribution [see Abstract 1006 (1928)]. The possible significance of the ratio 2·15/1·45 being nearly equal to $\sqrt{2}$, with reference to J. J. Thomson's theory [see Abstract 1312 (1924)], is commented on. At pressures below 50 mm. the current is resolved into ions and free electrons, and it is shown that an electron makes an average of $9{\cdot}4 \times 10^4$ collisions before capture, this number being independent of field strength or pressure and therefore of electron speed over a range of $2 \times 10^5 - 7 \times 10^5$ cm./sec. C. A. S.

2568. Diffraction of Electrons by Crystalline Powders. M. Ponte. *Comptes Rendus,* 188. *pp.* 244–246, *Jan.* 14, 1929.

Diffraction phenomena have been observed by the author with crystalline powders, using the arrangement employed for the study of powders by *x*-rays. The experiments were made with oxide of zinc. A narrow kathodic bundle from a hot kathode falls on a thin metallic wire covered with a feeble layer of zinc oxide or on the edge of a diaphragm on which the oxide has been formed; or it may traverse a "tissue" of zinc oxide formed without support. Thus the author has obtained fine rings of crystalline diffraction for tensions of 7·6, 11·17, 13·92 and 17·25 kilovolts. Figures of some of these are given. For 17·25 kilovolts twenty rings were visible. J. J. S.

2569. Temperature Dependence of Electron Emission under High Fields. W. V. Houston. *Phys. Rev.* 33. *pp.* 361–363, *March*, 1929.

An expression showing the temperature dependence of electron emission under high fields is secured by combining the results of Fowler and Nordheim [see Abstract 3286 (1928)] with the Fermi distribution of velocities used in the Sommerfeld electron theory of metals. The result is similar to that obtained previously by considering the diminution of the work function by the field. The temperature variation is small and decreases as the external field increases. It is of the right order of magnitude to agree with the most recent observations. AUTHOR.

2570. Secondary Electron Emission from Solid Metal Surfaces. C. F. Sharman. *Cambridge Phil. Soc., Proc.* 25. *pp.* 237–254, *April*, 1929.

The secondary electron emission from a metal surface produced by bombarding the surface with electrons of a given energy may be regarded as made up (*a*) of primary electrons elastically reflected, the energy distribution curve of these electrons consisting simply of a peak at approximately the incident electron energy value, and (*b*) of true secondary electrons. The energy distribution curve of the true secondary electrons consists of a peak at a comparatively low energy value, the curve on the high energy side of the peak falling off to zero inversely as the square of the energy up to a point within a few volts of the primary energy value. At this point the curve drops sharply to zero. A theoretical explanation of the general shape of this curve is developed, based on the classical dynamics of electron collisions. Measurements of the position and intensity of the peak in the low energy range were made, using the magnetic spectrum method, and it was found that the peak moved towards lower energies as the primary energy increased, a result in direct opposition to that previously found by the author using a differential retarding potential method (the experiments all refer to a polished copper target). Further experiments to test the shape of the curve on the high energy side of the peak were made, using a retarding potential method, and it was confirmed that the inverse square law of decrease held fairly well until the primary energy value was approached. W. S. S.

2571. Total Reflection of Electric Waves at the Interface between Two Media. H. M. Macdonald. *Roy. Soc., Proc.* 123. *pp.* 391–400, *April* 6, 1929.

The problem considered is the transmission and reflection of electric waves, when the surface separating two media is a sphere, and the source of the waves is a simple oscillator inside the sphere, whose axis passes through the centre of the sphere. The velocity of propagation in the outside medium is greater than inside the sphere, so that total reflection occurs. The changes in amplitude and phase for refraction or total reflection in the neighbourhood of the critical angle are examined in detail, and it is shown that the result obtained by considering a train of plane waves incident on a plane surface of separation gives the approximate values of the electric and magnetic forces in the two media near the surface at points which are not near to the boundary of the shadow in the second medium, and not near to the rays in the first medium incident at the critical angle, when the source of the waves is at a distance great compared with the wave-length. W. S. S.

2572. Measurements on Short-Wave Valves. H. Hornung. *Ann. d. Physik,* 1. 4. *pp.* 417–456, *Feb.* 15, 1929.

Short-wave valves of the type employed by Kohl [see Abstract 1374 (1928)] for wave-lengths below 1 m. were investigated, principally with the "grid" arrangement. The wave-length of the oscillations generated is determined essentially by the small oscillatory circuits of the valve itself constituted by the grid to anode capacity and their conducting leads bridged by a condenser. The dependence of the wave-length on the potentials applied to the grid and anode and on the emission was found to decrease with decreased wave-length; the results obtained in this connection were far from agreeing with the theory of Barkhausen and Kurz and Scheibe. For a given oscillatory circuit of the valve, (1) with constant anode and grid potentials the wave-length decreases nearly linearly with increased emission current. (2) With increasing grid potential, constant electron current and anode potential, the wave-length again decreases nearly linearly. (3) With increasing anode potential, constant electron current and grid potential, the wave-length increases almost linearly. No quantitative relations were found as regards the intensity ratios. The production of a comprehensive theory of the observed effects does not yet seem to be possible. A. W.

2573. Generation of Short Undamped Electric Waves by a Magnetic Field. A. A. Slutzkin and D. S. Steinberg. *Ann. d. Physik,* 1. 5. *pp.* 658–670, *March* 12, 1929.

A diode with a cylindrical anode of non-magnetic material and a straight concentric filament was arranged between the poles of a Dubois electromagnet so that the angle θ between the filament and the direction of the magnetic field could be varied. Parallel copper tubes 5 mm. diam. and 2 cm. apart were connected to anode and filament respectively, and copper rods sliding inside the tubes were joined by two small condensers in series. The connection between the condensers formed one element of a thermal junction connected to a galvanometer. The points of connection of the copper rods to their respective condensers were joined to batteries to give voltages up to + 300 and − 300 volts. With the angle θ zero the oscillations observed were very weak, but as θ was increased the amplitude increased to a maximum at about 10·5°. Beyond this the amplitude rapidly decreased and the oscillations died out completely for an angle of 14°. The wave-length could be calculated very approximately from the time of flight of the electrons from the filament to the anode. Wave-lengths were obtained varying between 85 and 7·3 cm. and tables are given showing the variation of wave-length with filament current, anode voltage, anode diameter and the strength of the applied magnetic field. Oscillations were also obtained with an ordinary triode using the grid as anode, the anode being left disconnected or having a suitable negative potential applied to it. For the shortest waves obtained with the diodes the diameter of the anode was only 3 mm. A. W.

2574. Investigation of Electrolytic Generator. W. M. Schulgin. *Phys. Zeits.* 30. *pp.* 235–237, *April* 15, 1929.

A description has previously been given of an arrangement using an electrolytic detector for the generation of high-frequency oscillations [see Abstract 940 (1929)]. The present paper gives details of the results obtained using a number of different concentrations of HCl, $MgSO_4$ and H_2SO_4 as electrolyte. A platinum wire was used for all except the H_2SO_4; with this an iron wire was employed. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2575. Electronic Theory of Metals and the Mean Free Path of the Electrons. L. Brillouin. *Comptes Rendus*, 188. *pp.* 242–244, *Jan.* 14, 1929.

Sommerfeld has obtained remarkable results by applying the statistical method of Fermi to free electrons in metals. To complete this theory it is necessary to calculate the mean-free path of the electrons, which has been done by Houston, Frenkel and Mirolubow. These authors base their calculations on undulatory mechanics and replace a bundle of electrons by a plane wave. Then they study the diffusion of this wave following the thermal agitation of the atoms of the metal. The methods are based on those which permit the calculation of the diffusion of light or of x-rays in a crystal. On noting this similarity of the two calculations their weak point is immediately perceived. The results cannot be similar for light, which obeys the statistic of Bose-Einstein, and for electrons, which follow the statistic of Fermi, and are regulated by the principle of Pauli. This point is developed mathematically by the author. J. J. S.

2576. Criticism of the Electronic Theory of Metals. H. M. Barlow. *Phil. Mag.* 7. *pp.* 459–470, *March*, 1929.

It is shown experimentally that the assembly of free electrons in the interior of a metallic conductor invariably behaves like a perfectly incompressible fluid and not like a " degenerate " gas, as required by Sommerfeld's electronic theory of metallic conduction. No instantaneous and reversible change of resistance was observed on charging and discharging a conductor. J. S. G. T.

2577. Measurement of Conductivities by means of Oscillating Circuits. S. D. Gehman and B. B. Weatherby. *Phil. Mag.* 7. *pp.* 567–569, *March*, 1929.

The authors point out that the results obtained by Burton and Pitt [see Abstract 2186 (1928)] are scarcely in agreement with the assumption that they are due to the conductivities of the various liquids inserted within the coils of the oscillating system, and express the opinion that the effects noted are due to the dielectric constants of these liquids. This view is supported by experimental results repeating and amplifying those of Burton and Pitt. C. A. S.

2578. Electrical Conductivity of Carborundum. H. J. Seemann. *Phys. Zeits.* 30. *pp.* 143–144, *March* 1, 1929.

It has been suggested that carborundum is a non-conductor [see Abstract 1811 (1925)]. The present measurements made on six crystals give, on the contrary, a value for the specific resistance of about 0·1 ohm./cm.^{3}. There is a brief discussion of the nature of the conducting properties of carborundum. A. A. D.

2579. Electrical Conductivity of Thin Oil Films. H. E. Watson and A. S. Menon. *Roy. Soc., Proc.* 123. *pp.* 185–202, *March* 6, 1929.

Vaseline and heavy paraffin oils are now widely used for application to plugs and sliding contacts in measuring instruments. Ordinarily these substances are regarded as insulators, and the present is a detailed investigation of the region in which a transition from insulation to conduction appears to take place. Methods are described for determining non-conducting film thicknesses by means of capacity measurements. There is a strong tendency for a film of air of the order 1 to 4 μ in thickness to form between two plane surfaces, particularly if one of them be slightly greasy. Hardy's measurements are confirmed, and his hypothesis that the film thickness is unchanged when the air is replaced by oil shown to hold good, with certain limitations, to at least 5 %. The thickness also shown to be nearly independent of the air pressure down in 2 mm. The coefficient of friction for the air film between contaminated surfaces decreases with increase of pressure, although the distance between the surfaces remains nearly constant and there is no relation between the coefficient of friction and the thickness. Air films have a high insulation resistance and when they break down the resistance usually becomes very low. Flooded films of paraffin oil will stand over 100,000 volts/cm. so long as their thickness is more than about 15 μ. At 11 μ there is a tendency to break down with a much smaller potential-gradient, and the breakdown thickness does not vary greatly with the voltage. The film becomes conducting in two stages: in the first the resistance is of the order 1 megohm, Ohm's law is not obeyed, but there is a tendency for the e.m.f. across the film to remain constant with variation of currents for a certain range; in the second stage the resistance is very low. A. D.

2580. Electrical Conductivity in Strong Magnetic Fields. Parts I and II. P. Kapitza. *Roy. Soc., Proc.* 123. *pp.* 292–372, *March* 6, 1929.

The experiments were carried out with the apparatus previously used in the investigation of bismuth crystals. Several improvements were introduced in the apparatus. It was used to measure the increase of resistance in a transverse field at room-temperature, at the temperature of solid CO_2 and ether, and at the temperature of liquid air or nitrogen, of thirty-five metallic elements. The change in resistance in a parallel field was measured for a few of these metals. In all metals the formula for the change of resistance shows proportionality to the square of the field for weak fields, and a linear relation for strong fields. To ensure that impurities should have only a small effect on the results the substance should not be less than 99·9 % pure, and even purer than this in the case of the lighter elements. No previous investigators have worked with such high fields, and their results only cover the part of the curve where the square law holds. In Part II a theory is advanced which assumes that the true or ideal resistance of a metal follows a linear law, and that this is marked in weak fields by disturbances in the metal, equivalent to those which could be produced by an internal magnetic field. It is possible by means of the formulæ obtained to separate the ideal and the additional resistances. The ideal resistance is identical with the residual resistance observed close to the absolute zero. The relation of the theory to supra-conductivity is discussed. The paper concludes with some remarks on the bearing of the research on the theory of metallic conduction. H. N. A.

2581. Superconducting Combination from Two Non-Super-Conductors. W. J. de Haas, E. v. Aubel and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 226–230, 1929. *In German. Comm. No.* 197*a from the Phys. Lab., Leiden.*

The resistance-temperature curve for the eutectic alloy of gold and bismuth (17·7 % gold, m.p. 240°) in liquid helium was examined. Bismuth from two sources was used, (*a*) a very pure sample from Matthey, and (*b*) a slightly less pure one from Hilger showing slight traces of silver, copper and lead. Both alloys were superconducting, but (*a*) showed a residual resistance of approximately 0·74, dropping to zero at 2·041° K.; while (*b*) showed one of 0·16, the drop to zero occurring at 1·915° K. The results are discussed and the possibility of their being due to impurities mooted. Further experiments with more carefully purified materials are in hand. C. A. S.

2582. New Method of Measuring the Electrical Resistance of Alloys. A. L. Norbury. *Phil. Mag.* 7. *pp.* 662–669, *April,* 1929.

In attempting to measure the diameters of Brinnell impressions by means of the change of contact resistance it was found that the specific resistance of the material influenced the results. Further investigation showed that there is a definite relation between the resistance, the diameter of the impression and the specific resistance, so that the method can be used to determine specific resistance. Similar results were obtained for 90° cones, and curves for both sets of experiments are given. W. G. B.

2583. Comparison of the Corbino and Hall Effects in Silver and Brass. K. K. Smith and H. M. O'Bryan. *Phys. Rev.* 33. *pp.* 66–74, *Jan.,* 1929.

An improved method was used to measure the Corbino effect by the electromagnetic torque on a circular disc of metal carrying a radial electric current, the disc being subjected to a magnetic field having a component normal to the plane of the disc. Then the Corbino effect is exhibited, *viz.,* the existence of a steady circular current whose density varies inversely as the distance from the centre. In the new arrangement of the authors the torque is balanced by sending a control current through one turn of insulated wire encircling the disc. The disc and control currents are led in and out through two pairs of spirals of silver ribbon. In fields of 8880 and 10,100 gauss the Corbino coefficient, c, of silver is $-5\cdot9 \times 10^{-7}$ and $-5\cdot8 \times 10^{-7}$ e.m.u. respectively. With a rectangular plate of silver, and using Heaps' method, c was found to be $-5\cdot0 \times 10^{-7}$, the Hall coefficient $R = -8\cdot6 \times 10^{-4}$ and the resistivity $\rho = 1\cdot72 \times 10^{3}$ e.m.u. For Navy brass the corresponding values are $c = -0\cdot14 \times 10^{-7}$, $R = -0\cdot96 \times 10^{-4}$ and $\rho = 6\cdot7 \times 10^{3}$ e.m.u. With these numbers obtained by the improved method the theoretical relation $c = R/\rho$ is satisfied. J. J. S.

2584. Photoelectric Effect in Red HgI_2. L. Piatti. *N. Cimento,* 6. *pp.* 14–35, *Jan.,* 1929.

In previous work (*Rendiconti R. Istituto Lombardo di Scienze e Lettere XL,* p. 942, 1927), the author found that with a red HgI_2 cell excited by intermittent solar rays, the sound in the telephone (with a thermionic valve) was reinforced by the interposition of some centimetres of water.

He now traces this to a lowering of the temperature of the HgI_2, when the infra-red rays of the exciting beam are eliminated. This leads to a new method of determining the point of transformation of red HgI_2 into yellow, a point as to which previous researches have been very discordant.
A. D.

2585. Dielectric Constant of Sulphur. S. Rosental. *Acad. Polonaise Sci. et Lettres, Bull. 8a. pp.* 377–395, *Oct.*, 1929. *In French.*

The dielectric constant of liquid sulphur, from 150° down to 90°, follows the Clausius-Mossotti law, *i.e.*, there are no electric doublets. At the instant of solidification of the sulphur the dielectric constant rises abruptly. Solutions of sulphur in benzene, solutions of sulphur in sulphide of carbon, and pure bisulphide of carbon itself, all follow the Clausius-Mossotti law. The polarisation of these solutions of sulphur can be ascertained from the polarisation of sulphur and that of its solvent, according to the Lorenz-Lorentz law. A. D.

2586. Dielectric Constants of Liquids. L. Hartshorn and D.-A. Oliver. *Roy. Soc., Proc.* 123. *pp.* 664–685, *April* 6, 1929.

Discussion of the various methods used for measurement, and the errors in these. A new method introduced, making a determination of the dielectric constant with a probable error of only one part in ten thousand. This method applied to benzene, with the view of obtaining a standard of comparison. The dielectric constant of benzene at 20° C. is $2 \cdot 282_{5 \pm 5}$ (vacuum = 1). A. D.

2587. Electric Moment of Ethylene Chloride and Ethylidene Chloride. P. N. Ghosh, P. C. Mahanti and D. N. Sen Gupta. *Zeits. f. Physik,* 54. 9–10. *pp.* 711–714, 1929.

In this investigation the determination of the permanent dipole moments of ethylene chloride and ethylidene chloride is made by means of a suspension null-method. The well-known Debye equation $(\epsilon - 1) MT/(\epsilon + 2)\rho = a + bT$ is employed for calculating the moments, these being respectively $1 \cdot 567 \times 10^{-18}$ and $2 \cdot 045 \times 10^{-18}$. The previously published electric moments of CH_3I, C_2H_5Br, C_2H_5I, CH_2Cl_2, CH_2Br_2 and other organic vapours are discussed, and an approximation conception is given of their structure. [See also Abstract 1314 (1929).] H. H. Ho.

2588. Electric Dipole Moment of Penta-Erythrite by the Molecular-Ray Method. J. Estermann. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 287–288, *April,* 1929.

By measurement of the deviation of molecular radiation in an inhomogeneous electric field it is shown that the molecule of penta-erythrite has an electric dipole moment, which is estimated at 2×10^{-18} c.g.s. approx.
H. H. Ho.

2589. Calculation of the Molecular Polarisation of Dissolved Substances at Infinite Dilution. G. Hedestrand. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 428–444, *April,* 1929.

The formula $P_\infty = (\epsilon_1 - 1)(M_2 - \beta M_1)/(\epsilon_1 + 2)d_1 + 3M_1 a \epsilon_1/(\epsilon_1 + 2)^2 d_1$ is derived giving the molecular polarisation at infinite dilution in terms of the dielectric constant ϵ_1 and density d_1 of the pure solvent, M_1 and M_2 being the molecular weights of the solvent and solute respectively, whilst a and β are constants. This formula has been applied to determine the molecular polarisation and dipole moments of a large number of organic substances, tables of data being included in the paper. [See also Abstract 1703 (1928).] H. H. Ho.

2590. Molecular Structure and Dipole Moment. W. Hückel. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 451–457, *April,* 1929.

In this paper it is shown that the presence of dipole moments in compounds of the type Ca_4 is not contradictory to classical stereochemistry. H. H. Ho.

2591. Inductances and Effective Resistances of Iron-Cored Coils. L. Hartshorn. *Journ. Sci. Instruments,* 6. *pp.* 113–115, *April,* 1929.

A method is described for the measurement of the effective inductance and resistance of coils of large self-inductance, which are required to carry a comparatively large direct current, with a superposed alternating-current ripple. Hay's inductance bridge is used, with special arrangements for the independent control and measurement of the a.c. and d.c. components, the avoidance of earth-capacity effects without earth connecting the d.c. supply, and the elimination of the direct current from the vibration galvanometer used as detector, without losing sensitivity. Typical results are given. AUTHOR.

2592. Tachymetric Measurement of Very Weak Electric Currents. C. Guilbert. *Comptes Rendus,* 188. *pp.* 861–863, *March* 18, 1929.

The apparatus consists of a gold-leaf electroscope and a variable condenser, by means of which the position of the gold leaves is kept constant. Currents of the order 10^{-13} can be measured. T. M. L.

2593. Application of a Valve Amplifier to the Measurement of X-ray and Photoelectric Effects. J. Brentano. *Phil. Mag.* 7. *pp.* 685–691, *April,* 1929.

A criticism of a paper by C. E. Wynn-Williams [see Abstract 3306 (1928)] on the same subject. A note on the possible application of "screened-grid" valves to the amplification of very small currents is also given. G. E. B.

2594. Kipp Galvanometer. Amelia di Muro. *N. Cimento,* 6. *pp.* 60–69, *Feb.,* 1929.

A mechanical study of this galvanometer, and specially of the conditions under which it enters into rotatory motion. A. D.

2595. Simple Earthing Switch for Small Electrometers. E. B. Moss. *Journ. Sci. Instruments,* 6. *pp.* 124–126, *April,* 1929.

A small earthing switch is described which is particularly suitable for use on a Lindemann electrometer. It is suitably shielded, and adds little to the capacity of the instrument. AUTHOR.

2596. Lenard Ray Tube with Glass Window. C. M. Slack. *J.O.S.A. and R.S.I.* 18. *pp.* 123–126, *Feb.,* 1929.

The inconveniences experienced with Lenard ray tubes due to the use of windows of thin aluminium foil have been largely overcome by the employment of thin glass windows. These windows are constructed by drawing in the end of glass tubing to form a bubble, the glass having been previously thinned at this point. Such a window 2·5 c.m. diameter and of thickness 0·0005 c.m. will stand atmospheric pressure applied on the concave side, and will only absorb about 3 % of the electron energy with 100 kilovolts across the discharge tube. By earthing the anode and the outer conducting sheath extending beyond the window, making the kathode end 100 kilovolts negative and placing a metallic plate at 100 kilovolts positive in front of the window outside the tube, it was found that the range of the rays was materially increased. Attempts are being made to adapt this type of window to oscillographic uses, and the results so far seem promising. A. W.

2597. Contacts in Apparatus for Measuring Electrical Resistivity. J. L. Haughton. *Journ. Sci. Instruments,* 6. *pp.* 120–124, *April,* 1929.

In the measurement of electrical resistances by means of potential drop methods four contacts are required. Methods for making these contacts with the resistance to be measured, both in the cold and at high temperatures, are discussed, and types of contacts suitable for different requirements are specified. AUTHOR.

2598. Bismuth-Tellurium Thermocouple and its Practical Applications. M. A. Lewitsky and M. A. Lukomsky. *Phys. Zeits.* 30. *pp.* 203–205, *April* 1, 1929.

Details of the behaviour of bismuth-tellurium couples, which are found to have low resistance, low-thermal capacity, and to give a high variation of voltage with temperature. The bismuth-tellurium couple gives 25 millivolts for about 100° C. between hot and cold junction, as compared with some 5 millivolts per 100° C. given by iron-constantan couples.

G. E. B.

ALTERNATING CURRENTS AND MAGNETISM.

2599. Skin Effect in Rectangular Conductors at High Frequencies. J. D. Cockcroft. *Roy. Soc., Proc.* 122. *pp.* 533–542, *Feb.* 4, 1929.

The problem of the high-frequency resistance of cylindrical conductors of rectangular section may be attacked by treating the conductor as an ellipse of large eccentricity. At high frequencies the surface of the conductor becomes a stream-line in the magnetic field, and the problem of the distribution of the field becomes analogous to an electrostatic problem. In the case of a rectangular conductor it is possible to calculate the electrostatic field outside an isolated cylindrical conductor of rectangular section, using the method of the Schwartz-Christoffel transformation. The solution of this electrostatic problem, extended to include the use of curved edges, was recently worked out by the author in a form suitable for numerical computations and field distributions for a number of actual cases. In the present paper the solution is applied to the skin-effect problem, and the results compared with the results for the ellipse and with such experimental data as are available. J. J. S.

2600. Equivalent Circuits and Reactive Power. C. Rimini. *N. Cimento,* 6. *pp.* 70–77, *Feb.,* 1929.

Shows that any network, fed with alternating current of constant frequency, may be assimilated to an arrangement of three impedances. Extension of this to the case of network divided into parts under mutual static induction. Leads to a confirmation of the principle of energy and, on the other hand, to an explanation of certain industrial processes of phasing circuits. A. D.

2601. Magnetostriction of Various Steels. J. S. Rankin. *Roy. Techn. Coll. Glasgow, J.* 2. *pp.* 12–19, *Jan.*, 1929.

In this paper a method of finding the alteration in length of various steels when subjected to magnetising forces is described, the small changes involved being measured by oscillating thermionic valves. AUTHOR.

2602. Modern Theories of Magnetism. L. Bruninghaus. *R.G.E.* 25. *pp.* 197–210, *Feb.* 9, *and pp.* 237–244, *Feb.* 16, 1929.

The author establishes the general theoretical relations which hold for diamagnetic and paramagnetic bodies, and deals with Langevin's theory of diamagnetism and Curie's law and the conditions under which these hold. For ferromagnetic bodies the theory is applied to the cases (1) in a zero external field, (2) in an external field at or below the Curie point, and (3) in an external field above the Curie point. A number of related phenomena are then considered; (1) specific heat anomalies, which form a means of checking and confirming the ideas established on magnetism; (2) magneto-thermal phenomena, such as the sharp change of temperature on establishing or terminating a magnetic field; (3) the Barkhausen phenomenon; (4) the nature of the field peculiar to the atom and its magnetic origin. The experiments of Stein and Gerlach are discussed and the method of calculation for Bohr's magnetion examined for Ag, Cu and Au. Finally, the results of a large series of experiments are summarised by which the atomic moments have been established for (1) the ferromagnetic bodies Fe, Ni and Co, (2) the paramagnetic gas O_2, (3) the paramagnetic salts in aqueous solution of Fe, Ni and Co, and (4) the paramagnetic solid salts. R. S. R.

2603. Theory of Auroræ and Magnetic Storms. H. B. Maris and E. O. Hulbert. *Phys. Rev.* 33. *pp.* 412–413, *March*, 1929.

The authors' table of molecular density and temperature is extended to cover night and day conditions, and for quiet and active sun conditions, the solar quiet being that with no terrestial auroræ or magnetic storms. The sun causes an excitation, dissociation and ionisation of the atoms and molecules, and on the sunlit side of the earth this ion spray extends to 50,000 km. These are ionised by ultra-violet light from the sun at big heights and descend spirally along the earth's lines of magnetic force to the magnetic poles, the aurora being formed by the recombination of the ions. This theory supplies an explanation of the latitude and hour for maximum auroral display, the streamers and the energy and frequency of the display while assisting in the explanation of the passage of short wireless waves in polar regions. At times of solar activity the sun increases largely the energy in the ultra-violet region. The general effects of this solar ultra-violet flash on the temperature, winds, ionisation, ozone, auroral light, etc., of the high atmosphere and on comets are discussed, and its bearing on the reflection of wireless waves. The theory is then applied to furnish an explanation of the world-wide magnetic storms and the accompanying phenomena, the energy arising from the fall of long free-path ions from the storm level of 1300 km. to the quiet day level of 300 km. Finally, the theory of diurnal magnetic storm variations is discussed. [See Abstract 1094 (1929).] R. S. R.

2604. Wireless Telegraphy and Magnetic Storms. H. B. Maris and E. O. Hulbert. *I.R.E., Proc.* 17. *pp.* 494–500, *March*, 1929.

A recent theory of auroræ and magnetic storms [see preceding Abstract] attributes these phenomena to the action of a flash of ultra-violet light from the sun. The flash causes an unusual ionisation in the Kennelly-Heaviside layer. Therefore it is only daylight wireless circuits which are, or may be, disturbed at the commencement of the magnetic storm, the night circuits remaining normal until dawn, when they may be disturbed; the disturbance in the daytime circuits may persist after nightfall. This very simple theory is found to be borne out in a detailed discussion of the data of the short-wave (15 to 40 m.) circuits of the United States Navy during the magnetic storms of May 28, July 7, October 18 and October 24, 1928. AUTHORS.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2605. Physiology and Radiant Energy. H. Laurens. *J.O.S.A. and R.S.I.* 18. *pp.* 237–252, *March,* 1929.

This paper does not lend itself to abstraction, but gives a well-balanced account of modern artificial light treatment and associated facts. It is quite up to date as regards recent work. B. J. L.

2606. Applications of Electricity to Medical Practice. G. G. Blake. *Roy. Soc. Arts, J.* 77. *pp.* 236–261; *Disc.,* 261-264, *Jan.* 18, 1929.

A general discussion of the use of electricity in medicine, the lecture being largely of an historical nature. Some of the subjects referred to are ultra-violet therapy, ionic medication, the measurement and recording of human emotion with a thermionic amplifier. The history of the discovery and development of X-rays in this country is treated more fully, both diagnostic and therapeutic use being discussed. The paper concludes with sections on the use of high potentials therapeutically by direct charging of the patient and the production of spark photographs of thumb prints. In the *Discussion,* **A. Campbell Swinton** and **O. Lodge** took part. The latter described certain experiments by himself of electrotherapeutic interest and referred to a " catalytic " theory of cancer. W. V. M.

2607. Diathermy. L. E. Pariseau. *Canad. Medical Assoc., J.* 20. *pp.* 146–152, 1929.

A description of some experiments on the distribution of heating effect in agar-agar when high-frequency currents are passed through it between metallic electrodes. The heating is detected by loading the agar with silver tetraiodomercuriate which is canary-yellow when cold and orange-red when hot, the rise in temperature required to cause the change being small. The places of maximum heat production using various electrodes and dispositions are described. The author emphasises the value of the " thermoscopic " method in the investigation of such problems. W. V. M.

2608. Biological Action of Short Electric Waves. E. Schliephake. *E.T.Z.* 50. *p.* 574, *April* 18, 1929.

Experiments made upon rabbits and guinea-pigs show that an increased body temperature can be induced by short waves of 3 to 5 metres, the action being purely due to the field variations and not direct conduction, as in diathermy. Persons operating transmitters also show nervous effects and increase of body temperature by long-continued work. Such nervous effects can also be induced experimentally in animals. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2609. Sorption of Pyridine Vapour by Upper Silesian Coal and by its Petrographic Modifications. W. Swietoslawski and M. Chorazy. *Acad. Polonaise Sci. et Lettres, Bull.* 8*a. pp.* 361–365, *Oct.,* 1928. *In French.*

The different petrographic modifications of Upper Silesian coal absorb different quantities of pyridine vapour. Thus, in twenty-six days, the vitrain absorbs 70·4, the durain 54·5, and the fusain 12·8 % of the vapour; these results being calculated on the dry ash-free material. The proportion of pyridine vapour absorbed by different types of Upper Silesian coal increases with the coking property. T. H. P.

2610. Refraction Constants and Solution Volumes of Certain Organic Compounds in Aqueous Solution. E. Berner. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 91–124, *March,* 1929.

From the results of measurements of the refractive indices and densities of dilute aqueous solutions of ethyl alcohol, normal and secondary propyl and butyl alcohols, acetone, methyl ethyl ketone, and the isomeric methyl tartrates, the molecular refraction constants and solution volumes are calculated. The refraction constants in solution agree well with those of the homogeneous substances, and hence show similar additivity. The values obtained for the solution volume demonstrate, however, that this magnitude is influenced to a far greater extent by the structure and the configuration. By following the gradual hydration of the anhydrides of succinic, methylsuccinic and glutaric acids in the dilatometer and interferometer, the refraction constants and solution volumes of the anhydrides and the corresponding free acids are derived. The results show that the oxygen ring in glutaric anhydride conditions a higher refraction constant and a lower solution volume than that in the anhydrides of succinic and methylsuccinic acids. The difference in the refraction constant, according to Gladstone and Dale's formula, is 0·34, and according to Lorenz and Lorentz's formula, 0·18; while the difference in the solution volume is about 1 millilitre. T. H. P.

2611. Colloidal Platinum. Parts V and VI. Coagulation by Electrolytes in Acid Solution; Behaviour of Platinum Sols in Basic Solution. S. W. Pennycuick. *Chem. Soc., J. pp.* 618–633, *April,* 1929.

Addition of salts to colloidal platinum sols causes replacement of the hydrogen ion of the surface hexahydroxy-acid by the kation of the salt, this kationic interchange preceding and leading directly to coagulation. In acid solutions the kationic interchange is only partial, and the coagulum contains some of the surface acid, this explaining the increase in the coagulating power of a salt as the p_H of the sol is decreased. With ferric chloride and aluminium sulphate, at the usual low concentrations, the hydroxides set free by hydrolysis play no important part in the coagulation. The results obtained by addition of bases to colloidal platinum solutions indicate that approximately 25 % of the colloid surface consists of hexahydroxyplatinic acid, the rest of the surface apparently containing weakly acidic oxides of platinum. In terms of this interpretation the different actions of univalent and bivalent bases at the colloid surface are explained, as is also the remarkably effective protective action of univalent bases against salt coagulation. Contrary to general belief, platinum sols are reversible. The conditions of repeptisation are outlined and the results explained in terms of the theory. T. H. P.

2612. Thermolysis of Solid Salts. Ludwig-Soret Phenomenon. H. Reinhold. *Zeits. f. phys. Chem.* 141. *Abt. A.* pp. 137–140, *April,* 1929.

During an investigation on the thermoelectric properties of solid salts the thermolysis of solid salts was determined with mixed crystals of cuprous iodide and silver iodide. Compressed cylinders of a mixture of 25 mols per cent. cuprous iodide and 75 mols per cent. of silver iodide were heated to 250° C. in an atmosphere of nitrogen until the weight became constant and the mixed crystals were homogeneous. The ends were pressed together and heated so that a temperature difference of 100° C–120° C. existed in the cylinder. The heating was continued for four days. Changes of weight were found to have taken place in the cylinders of mixed crystals, the cylinder at the higher temperature having gained weight, that at the lower temperature lost the same amount. The total weight of the complete cylinder remained unaltered. F. J. B.

2613. Influence of Liquids on Formed Cellulose Hydrate. W. Lüdke. *Kolloid Zeits.* 47. *pp.* 341–351, *April,* 1929.

The great reduction in strength of fibres of cellulose hydrate when wetted with water is well known. The effects of liquids other than water on the strength of fibres of cellulose hydrate was investigated. The breaking strain and elongation of fibres of hydrocellulose, and of strips of cellophane, after immersion in various organic liquids were determined. The swelling produced by the organic liquids was less than that produced by water. The addition of small quantities of water to the organic liquid resulted in the reduction of strength characteristic of water. The chief effect of the various liquids depended on their water content, upon their behaviour towards water and their tendency to swell the cellulose. The liquids formed three groups—those which remove water, those which swell the cellulose, and neutral liquids. F. J. B.

2614. A Change from γ to α Iron in Certain Steels. A. Michel and P. Benazet. *Comptes Rendus,* 188. *pp.* 912–915, *March* 25, 1929.

Some special steels which have been made austenitic by heating to a high temperature and quenching return to the α-state suddenly at a certain temperature, showing a strong dilation and giving off a large amount of heat; in many cases light is also given off at this point. If the steel is then cooled the coefficient of contraction is considerably smaller than before. In other cases the return to the α-state is retarded owing to the presence of carbides and other compounds, which cause passive resistance to the change. The more these compounds are precipitated the sooner the transformation will take place during cooling, and the more sudden it will be. Experiments were made which showed that in these two kinds of steel the difference was only due to a difference in the velocities of reaction. For instance, a steel of the first kind, which showed the sudden explosive phenomenon under ordinary conditions when heated to 700° C., was found to behave like steel of the second kind when kept for seventeen hours at a temperature between 620° C. and 660° C. Even at the end of this period the change was not complete, but was completed during cooling. The only difference is in the values of the passive resistances, which are small in steels of the first category, and unable to prevent explosive change at a certain temperature. H. N. A.

2615. Studies in Chemical Dynamics of Autocatalytic Processes. J. Zawidzki and (Mme) W. Wyczalkowska. *Acad. Polonaise Sci. et Lettres, Bull.* 8*a*. *pp*. 293–360, *Oct*., 1928. *In German.*

A very complete investigation of the reactions which take place when dibromsuccinic acid loses hydrobromic acid in aqueous solution was made. The velocity of reaction and the order of reaction were determined at 75° C. The velocity of reaction was found to be in accordance with the equation: $dx/dt = k(a - x)/2x$, where $k = 0\cdot000154$ at 75° C. The same value was obtained for the reaction-velocity constant from the correspondingly modified equation when the reaction velocity was measured in the presence of HBr, HCl, HNO_3, Na_2SO_4, NaBr, KBr and NaCl. F. J. B.

2616. Theory of Heterogeneous Catalytic Reactions. Multiplet Hypothesis. Model of Dehydrogenation Catalysis. A. A. Balandin. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 289–316, *March*, 1929.

A scheme of heterogeneous catalytic reactions is proposed which is based on the assumption that active points of the surface orientate to themselves the chemical linkings requiring activation, and so facilitate the course of the reaction. It is also suggested that each active point usually attracts two atoms of the reacting molecule. On the catalysing surface there occur groups of such points (multiplets), characterised by specific attractive power and special configuration. This theory furnishes an explanation of the general phenomena, that, although catalysis is related to adsorption, an active adsorber need not be an active catalyser, and that catalysis is more sensitive towards poisoning than is adsorption. The scheme gives conditions for the parallel occurrence of the two phenomena and provides an interpretation of the action of promoters. The fact that, owing to poisoning, a reaction may be diverted to another course, renders it necessary to assume secondary condensation reactions in the catalysis of organic compounds. It follows also from the scheme that, in the dehydrogenation of cyclohexane by platinum, the symmetry elements of this molecule and that of the catalyst must be common, and on this foundation a model of dehydrogenation catalysis is constructed capable of explaining the principal facts observed, namely: six hydrogen atoms split off from cyclohexane simultaneously on catalysis; only six-membered rings can be dehydrogenated; metals alone, and only those that crystallise in the cubic and hexagonal systems (face-centred lattice) and possess atoms of definite size serve as catalysts of the dehydrogenation. The probable value for the dimensions of the hydrogen atom is worked out, and it is shown that neither cyclohexanes disubstituted at one carbon atom, nor trans-disubstituted cyclohexanes are capable of dehydrogenation catalysis. The activation energy of hydrocyclic compounds with condensed cycles depend not on the number of cycles in presence of one and the same catalyst, but solely on the chemical nature of the latter. On the same basis schemes are advanced to explain non-reversible and hydrogenation catalysis, and also the decomposition of hydrocyclic compounds. The question of the nature of the active catalytic centres is discussed; such centres are not specially loosely bound atoms, but, on the contrary, are found in the densest packing on elementary surfaces, and are identified with the crystallisation nuclei. T. H. P.

2617. Velocity of Combination of Hydrogen Atoms. Z. Bay and W. Steiner. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 146–147, *Jan.*, 1929.

The method of Wrede was employed. Atomic hydrogen was produced by means of electric discharges and passed through a long tube. The concentration of atomic hydrogen was measured at three points along the tube by means of diffusion slits, and the velocity of the gas stream was determined. With a pressure of 2×10^{-1} mm. Hg, for a concentration of 35 % of atomic hydrogen, the mean life was determined as $\tau = 1$ sec. This agrees with the value deduced by Bonhoeffer from chemical reactions, and is of the order of that deduced theoretically on the assumption of triple collisions. It is probable, however, that the result is only a lower limit, since it is affected by reactions at the wall of the tube. Further experiments are in progress. H. N. A.

2618. Ignition of Detonating Gas by Hydrogen Atoms. F. Haber and H. D. v. Schweinitz. *Preuss. Akad. Wiss. Berlin, Ber.* 30. *pp.* 499–506, 1928.

If, as suggested by Bonhoeffer and Haber [see Abstract 1186 (1929)], the combustion of detonating gas is a chain reaction expressed by the equations $OH + H_2 = H_2O + H$ and $2H + O_2 = 2OH$, a sufficient supply of either hydrogen atoms or hydroxyl radicles should serve to explode detonating gas at the ordinary temperature. It is found that this actually does occur in the case of hydrogen atoms. These atoms were obtained by Langmuir's method, by means of a high-tension arc, the gas being led off between walls wetted with liquid water, which rapidly removed the sensible heat and so prevented the hydrogen ions from reuniting. When the mixture of molecular and atomic (about 0·1 %) hydrogen was brought into contact with oxygen, explosion occurred only after a certain lag, the magnitude of which depended on the arc current strength. The explosion cannot be caused by the heat developed by the combination of hydrogen atoms either among themselves or with oxygen, since the amounts of heat so furnished would be insufficient to produce the required temperature. T. H. P.

2619. Kinetics of the Combination of Hydrogen and Oxygen. N. Semenoff. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 169–180, *Feb.*, 1929.

The work of Hinshelwood [see Abstract 2859 (1928)] on the homogeneous reaction between H_2 and O_2 is discussed on the basis that the experimental results indicate a chain reaction wherein the energy obtained from the intermediate substances of the chain produced activates the side branches of the reaction. The observations of Hinshelwood agree with this fairly well, but the research of the present experiments on the conditions of the explosion show certain exceptions to this theory. J. K.

2620. Chemical Phenomena Associated with the Contraction of Hydrogen in Discharge Tubes. R. Delaplace. *Comptes Rendus*, 188. *pp.* 708–710, *March* 4, 1929.

Traces of CO_2, CO and CH_4, as well as hydrogen, are liberated when pyrex glass is bombarded with kathode rays in a discharge tube containing hydrogen. T. M. L.

2621. Photochemical Equilibrium between Hydrogen, Bromine and Hydrogen Bromide. R. W. Armour and E. B. Ludlam. *Roy. Soc. Edinburgh, Proc.* 49. 1. *pp.* 91–96, 1929.

A series of experiments made to determine whether any trace of hydrogen bromide could be detected when a mixture of hydrogen and bromine is subjected to light of wave-length 185, and, if possible, to determine the quantity of hydrogen bromide present at equilibrium, and also to measure quantitatively the coefficient of absorption of bromine for the spectral range 245 $\mu\mu$, 185 $\mu\mu$. Carefully purified hydrogen was passed through bromine and the mixture exposed to the light rays from an aluminium spark. The mixed hydrogen and bromine were contained in a silica spiral, and the issuing gases were passed through water and the bromine and hydrobromic acid were estimated. The results showed that less than 1 % by weight of bromine enters into combination to give hydrogen bromide, under the conditions of the experiments. F. J. B.

2622. Theory of the Velocity of Chemical Reactions. N. Semenoff. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 161–168, *Feb.*, 1929.

The significance of reaction chains (substance chains and energy chains) for the kinetics of slow reactions and for the initiation of explosions is explained, and the source of the activation energy discussed. Such experimental data as are available are in accord with the theoretical considerations. T. H. P.

2623. Thermal Decomposition of Ozone at Low Pressures. L. S. Kassel. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 264–265, *Feb.*, 1929.

With reference to the results of Riesenfeld and Schumacher [Abstract 1008 (1929)] on the mechanism of the decomposition of ozone, the author has shown that the decomposition of complicated molecules is of the second order at high pressures, of the first order at lower pressures, and of the second order, with increased velocity constant, at still lower pressures. This second change has been observed with several reactions, such as the decomposition of azomethane, propaldehyde, etc., and that of acetaldehyde apparently represents an example of the first change. As regards the behaviour in this way of such a simple substance as ozone, it is pointed out that no other known triatomic gas decomposes unimolecularly, and that no other unimolecular reaction has so low a velocity; on account of this the bimolecular reaction should predominate at moderate pressures. Riesenfeld and Schumacher's proof that the first order reaction is homogeneous is not convincing. T. H. P.

2624. New Process for Preparing Phosphorescent Zinc Sulphide. R. Coustal and F. Prevet. *Comptes Rendus,* 188. *pp.* 703–705, *March* 4, 1929.

The product is obtained by exploding an intimate mixture of zinc and sulphur. T. M. L.

2625. Reactions in Ionised Gases. S. S. Joshi. *Faraday Soc., Trans.* 25. *pp.* 143–147, *April,* 1929.

The ratios M/F or *m/n* are theoretically and experimentally investigated for ionised gases, particularly nitrous oxide, where M denotes the number of gram moles of an electrolyte changed due to the passage of F faradays of electricity. J. K.

2626. Separation of Thorium from Uranium by Means of Ether. P. Misciattelli. *Phil. Mag.* 7. *pp.* 670–674, *April,* 1929.

To throw light on the divergent results obtained in the use of ether for the analytical separation of uranium and thorium, the anhydrous ternary system—uranyl nitrate, thorium nitrate, ether—is examined, and it is shown that the conditions for the thorium not to be dissolved are that the temperature must be above 20° C. and the uranyl salt sufficient to saturate the ethereal solution. AUTHOR.

2627. Action of Helium on Platinum. H. Damianovich. *Comptes Rendus*, 188. *pp.* 790–792, *March* 11, 1929.

Obtains the exothermic combination of helium with platinum by condensation of the product formed at low temperature after activation by the low-tension electric discharge. The properties of this product are distinct from those of platinum, and the material also contains a large amount of helium in a fairly stable state. Its colour is deep brown, and is deposited in the form of very thin laminæ; whilst when heated it decomposes, leaving a mirror surface of normal platinum. This decomposition occurs at a much slower rate than does the formation of the product.
R. C. F.

2628. Combustion of Platinum. E. K. Rideal and O. H. Wansbrough-Jones. *Roy. Soc., Proc.* 123. *pp.* 202–216, *March* 6, 1929.

Results are given of determinations of the loss in weight of a platinum filament heated to 1400°–1900° abs. in a sealed bulb surrounded by liquid air and filled with oxygen under pressures varying from 100 to 200 bars. At high temperatures the loss in weight of the filaments is more rapid in oxygen than *in vacuo*. The results obtained are most readily interpreted by postulating a surface reaction proceeding at a rate directly proportional to the pressure and a zero order bulk-phase reaction occurring simultaneously, the combined effect being denoted by an equation of the type

$$-\frac{dp}{dt} = a + bp \quad \text{or} \quad -bt = \log_e \frac{a + bp}{a + bP_0},$$

where P_0 is the initial pressure. The total loss in weight of the filament and the weight of oxygen cleaned up give the values 1·92, 1·95, 1·88, for the ratio Pt : O in the product formed, which may hence be assumed to be PtO_2. The energy of activation of the surface action is found to be 2·75 volts in contrast with Langmuir's value 0·87 volts on a tungsten surface. The difference between these two values, 1·87 volts, is identical with that of the thermionic work functions, and a hypothesis of the mechanism of these surface actions is suggested. It is shown that the oxidation of carbon and the catalytic decomposition of ammonia on various metallic surfaces fit into the scheme suggested. T. H. P.

2629. Regularities in the Ionic Radii of the Elements. A. M. Berkenheim. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 35–40, *March*, 1929.

The ionic radii, or more correctly the radii of the spheres of action of the atomic ions of the elements, calculated by the author [see Abstract 338 (1929)], agree on the whole better with the determinations of Goldschmidt than with Pauling's calculations and show certain regularities. Thus the radii of the positive ion are, *e.g.*, Li 0·624, Be 0·468, B 0·312, C 0·156 Å. Writing them in the opposite order and taking the value for C as unit, the author finds the ratios 1, 2, 3, 4. When similarly the fourth element of each horizontal series (Na, Mg, Al, Si; K, Ca, Sr, Ti), which also represents the fourth vertical column of the periodic system, is taken as unit, the other ionic radii appear as multiples (1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$; 1, $1\frac{3}{8}$, $1\frac{6}{8}$, $2\frac{1}{8}$, etc.), and when C = 1 is kept as unit throughout the system, similar (partly fractional) multiples are found for all the positive ions, rising to $10\frac{3}{8}$ for Cs. A similar

V.32
1929

relation holds for the negative ions, the radius of Cl′ being the arithmetic mean between the radii of the atom Ar and of the ion S″. H. B.

2630. Thermal Formation of Hydrogen Chloride. J. A. Christiansen. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 405–407, *April, and* 3. *p.* 401, *June*, 1929.

The formation of hydrogen chloride from chlorine and hydrogen has been investigated in the dark. The velocity of union at 200° at a definite oxygen pressure is found to be independent of the hydrogen pressure, but approximately proportional to that of the chlorine and inversely proportional to that of the oxygen. On the assumption that the reaction takes place mainly at the walls of the vessel, the result is explained on the Nernst atomic-chain mechanism. Various facts, such as the low-temperature coefficient of reaction support this assumption, and explain many of the discrepancies between the earlier investigations. The reaction was apparently inhibited somewhat by hydrogen chloride, but not by bromine. The author also describes a new micro-burette, and it was found that in an electrical thermo-regulator with iron-mercury contact the iron must be negative. H. H. Ho.

2631. Calibration of Conductivity Cells. Part I. At 18° C. C. W. Davies. *Faraday Soc., Trans.* 25. *pp.* 129–133, *April*, 1929.

The present paper refers to the Frazer and Hartley method of calibrating conductivity cells by measuring in them the conductivity of aqueous KCl at concentrations within the range at which the cell is going to be employed, and comparing these results with the standard figures of Kohlrausch and Maltby, these figures being subject at high dilution according to the author to a slight correction. The correction is to reduce all Kohlrausch's Λ_0 values by 0·06 units, or more. The equation $\Lambda = 129\cdot85 - 78\cdot8\sqrt{C}$ is put forward as a basis for cell determinations at low concentrations. J. K.

2632. Calibration of Conductivity Cells. Part II. Conductivity of Potassium Chloride at 25° C. J. Grindley and C. W. Davies. *Faraday Soc., Trans.* 25. *pp.* 133–137, *April*, 1929.

Full experimental details are given in this paper, the results obtained plotted, the figure showing also the earlier data obtained by other workers which are alleged not to be sufficiently accurate for cell constant determinations. The cell used is of the Hartley and Barrett type. The equation $\Lambda_c = 150\cdot59 - 109\cdot0\sqrt{C}$ is suggested as a basic for cell constant determinations at 25° C., for aqueous potassium chloride solutions up to 0·0015 N. J. K.

2633. Electrometric Determination of Lead Ion. H. Millet. *Faraday Soc., Trans.* 25. *pp.* 147–152, *April*, 1929.

The paper gives the results of an investigation of the lead electrode in very dilute systems with the object of being able to determine accurately the concentration of lead ion in very dilute solutions. Reference is made to the work of Allmand and Burrage on the lead electrode in $PbCl_2$–K . Cl systems. The lead-ion determinations are given for 25° C. by measuring the electromotive force of the cells of the type

$$Pb \mid Pb(NO_3)_2 \mid \text{Saturated KCl} \mid \text{Normal calomel electrode}$$

using neutral and acid solutions of lead nitrate. A lead electrode made by electrodeposition of lead upon platinum functions well in neutral solutions at low *lead-ion* concentrations. J. K.

2634. Very Thin Glass Electrodes. D. A. MacInnes and M. Dole. *Indust. and Eng. Chem.* (*Analytical Ed.*), 1. *pp.* 57–59, *April* 15, 1929.

Referring to the history of glass electrodes and to their own work the authors describe the preparation of active glass surfaces, only 0·001 mm. thick, for differential electrometric titration. A glass bulb is blown out until the film shows interference colours. The open end of a glass tube, heated to red glow, is then approached to the film, which, adhering, closes the tube by a very thin diaphragm of glass. Two such tubes are wanted in the titration apparatus; the tube diameter may be only 0·75 mm. The electrodes are said to respond only to changes in the concentration of the hydrogen ions and to be independent of the oxidation and reduction potentials. The resistance of these electrodes, made from various glasses, ranged from 18·7 megohms (special glass) up to immeasurable values (pyrex glass). The special glass contains 72 parts of SiO_2, 22 Na_2O, and 6 CaO, which is approximately the glass for lowest equilibrium temperature on Morey's three-component diagram. H. B.

2635. Electric Charge on Silver Iodide in Saturated Solutions of Silver Iodide. E. Lange and P. W. Crane. *Zeits f. phys. Chem.* 141. *Abt. A. No.* 4. *pp.* 225–248, *May*, 1929.

The phase limits between metallic silver and crystals of silver iodide and solutions of silver iodide were obtained from the equilibrium potential. The electrokinetic potential of silver iodide in a pure saturated solution, and in the presence of a small excess of potassium iodide and silver nitrate, was determined. A carefully washed sample of silver iodide (washed 80 times) showed a negative charge in AgI solution of -4 ± 1 millivolt. This was independent of the conditions of precipitation of the AgI, with excess of $AgNO_3$ or KI. AgBr and AgCl were also negative. The results were utilised to explain certain facts in colloidal chemistry. F. J. B.

2636. Maxima on Current-Voltage Curves. Part III. Electrolysis of Mercury Salt Solutions with Dropping and Steady Mercury Kathodes. P. Herasymenko, J. Heyrovský and K. Tančakivský. *Faraday Soc., Trans.* 25. *pp.* 152–159, *April*, 1929.

1. The maxima on current-voltage curves and the corresponding changes of interfacial tension were investigated in the electrodeposition of mercury at the dropping mercury kathode as the simplest case of a general phenomenon. 2. At steady mercury electrodes the same phenomena are observable; here, however, the current-voltage curves are less reproducible than with the dropping mercury kathode. 3. The current before the discontinuous fall is supported mainly by adsorption. The discontinuous decrease of the current accompanied by the setting in of the concentration polarisation is due to the formation of an interfacial layer of solution exhausted of mercury salts. The thickness of this layer prevents further adsorption of mercury salts to the kathode interface. 4. The maximum is suppressed by a large excess of an indifferent electrolyte or of adsorptive matter. This effect is explained by preferential adsorption of the added matter. AUTHORS.

2637. New Method of Studying the Electrochemical Behaviour of Substances in Dilute Solution. F. Joliot. *Comptes Rendus*, 188. *pp.* 1106–1108, *April* 22, 1929.

A preliminary note describing an apparatus for determining the velocity of electrolytic deposition of a non-radioactive substance [See Abstract 2558 (1927)] on an unattackable electrode from a very dilute solution. The deposition electrode consists of a glass plate ($3mm.^2$) on which a layer of gold or platinum (20–40 $\mu\mu$ thick) has been kathodically sputtered, ground into a corresponding hole in the side of the cell (5 cc. in volume). Opposite is a corresponding glass plate and a beam of light passes through both. The velocity of deposition is measured by the increase in optical density of the electrode. The method is one of extreme sensitivity, a deposition layer two atoms thick being determinable. It was applied to solutions of bismuth nitrate 10^{-6}–10^{-4}N, and of tellurous acid 10^{-3}N, the weight of deposit not exceeding 10^{-5} gm. C. A. S.

2638. Reversible Electromotive Force of Electrolysis. J. Vuillermoz. *Comptes Rendus*, 188. *pp.* 1098–1099, *April* 22, 1929.

A very brief note without experimental details in which the author concludes by comparing the variations in the potential of a platinum electrode negatively polarised by a current of 0·2 to 2 mA/cm^2. in a 2*N* solution of sulphuric acid, when the current is simply broken and when the breaking is accompanied by a static discharge of varying strength across the electrode-electrolyte contact, that this contact is equivalent to two circuits in parallel, one behaving as a condenser (of capacity 10–20 microfarads), the other forming the resistance to the reversible e.m.f. C. A. S.

2639. Becquerel Effect. I. Lifschitz and S. B. Hooghoudt. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 52–70, *March*, 1929.

Continued experiments show that Winther's sharp discrimination between surface effect at the electrode and volume effect in the electrolyte [see Abstract 1097 (1928)] cannot be sustained. Under the influence of radiations new molecules or substances are formed in the electrolyte which diffuse to the electrode and produce there changes of potential, as Russell [see Abstract 639 (1929)] concluded from other arguments. A cell combination $Pt/NCuSO_4aq$/unpolarisable electrode does not differ essentially from: $CuO/NKCl$/unpolarisable electrode. In the latter case only the electrode is radiated upon. The volume effect in the former case cannot be referred to simple photochemical displacement of equilibrium such as takes place in the oxidation and reduction of cerium salts, where the potential changes are not really Becquerel effects. Most Becquerel-effect measurements are made with open chains and can only give information of qualitative value as to direction and order of magnitude, because the dark potentials are very difficult to reproduce. The experiments show the great influence of small quantities of impurities in the electrolyte, and of the stirring gas (nitrogen). The electrode material (Pt, Au, Ir, Hg, W) has no decided influence; the influence of the electrode area is small. The Becquerel effect is strong also in electrolytes (organic dyestuffs) dissolved in absolute alcohol, benzonitrile and acetonitrile (instead of water) and in the absence of $H^{\cdot}$ and OH', and is not limited to a small number of electrolytes. The photoproducts probably do not represent special oxidation stages (which was already proved by E. Baur), but rather primary products of higher energy, which have a longer life than is usually assumed, but can only form at solid electrode faces. H. B.

2640. Inversion of the Photovoltaic Effect. G. Athanasiu. *Comptes Rendus*, 188. *pp.* 786–788, *March* 11, 1929.

From an examination of the addition of OH^- ions and H^+ ions to an electrolyte in a pile in which various electrodes are used, the effect of this addition on the Becquerel photovoltaic effect is found to be dependent on the types of electrodes used. Ag — AgI, Ag — AgBr, Ag — Ag_2S, Hg — Hg_2I_2, Cu — Cu_2I_2, Cu — Cu_2Br_2 and copper oxide electrodes were examined, and the addition of OH^- ions to the electrolyte when Ag — AgI, Hg — Hg_2I_2, Cu — Cu_2I_2 and Cu — Cu_2Br_2 electrodes are used produces a reversal of the normal positive photovoltaic effect. The reversal to a lesser degree is noticeable with Ag — AgBr electrodes. For Ag — Ag_2S electrodes, with which a normal negative effect is obtained, the addition of OH^- ions increases this effect, whilst H^+ ions also increase the positive photovoltaic effect obtained with copper oxide. The region of maximum sensitivity of each pile is also given. A discussion of results leads to two probable explanations. For the same electrode it is possible that the same radiation can produce the two observed effects and that the direction of the phenomenon depends on the electrolyte. The phenomena can also be explained on the assumption that the illuminated electrode is the seat of photochemical reactions in which the ions of the electrolyte take part. R. C. F.

2641. Potential Effect of Electrolytic Conductivity in very Strong Fields. M. Wien. *Ann. d. Physik*, 1. 3. *pp.* 400–416, *Feb.* 9, 1929.

The author has previously shown that the potential effect of the electrolytic conductivity in very high fields tends towards a limiting value, and has already published a short summary of the results given in the present paper [see Abstracts 2754 (1927) and 949 (1929)]. He now gives a more exact account of the results and the comparison of the limiting effect with the concentration effect and the theory. This limiting or border-line effect agrees well with the concentration effect within the limits of error in the case of the solutions examined, and also agrees with the values given by the Debye-Onsager theory in the case of ions of small valency. But for solutions with ions of high valency the theoretical values are too small when confronted with the limit effect and the concentration effect. According to Debye and Falkenhagen the influence of the ionic forces must disappear with a sufficiently strong field. An existing association must thus cause the limiting effect to come out lower than the concentration effect. Since also, in the case of solutions with high-valency ions, limiting effect and concentration effect agree within the limits of error, an influence of the association does not come in for the case of the very dilute solutions of strong electrolytes, which were those investigated. J. J. S.

2642. Conductivity of Solutions of Some Aliphatic Organic Acids. H. Hunt and H. T. Briscoe. *J. Phys. Chem.* 33. *pp.* 190–199, *Feb.*, 1929.

This paper deals with the conductances of solutions of various fatty acids and their substitution products in water and ethyl alcohol. The main points are the effect of the substituent upon the conductivity of the acids in alcoholic and aqueous solutions and the relative effects of the substituent upon the conductivities of the acids in solutions of the two solvents. In so far as possible the data have been used to measure the relative ease with which H may be dissociated from the remainder of the acid molecule in each of the two solutions. The following results were obtained: (1) all the acids studied have a much lower molecular conductance in alcohol than in water; (2) the rate of increase of molecular conductance for the successive dilutions is about twice as great in alcohol as in water; (3) the homologous fatty acids fall in a series with a decreasing molecular conductance as the number of C atoms increases; isovaleric acid in water solutions and the caproic acids in alcohol being exceptions; (4) the data do not consistently confirm Lewis' theory of the effect of substitution of groups possessing different electrical characteristics upon the strength of the acid; (5) the acids do not have the same relative conductivities in alcohol and in water solutions; (6) the substituent radicals have been arranged in the order of their effect upon the conductivity of the acid molecule in both water and alcohol; (7) the log-volume conductance curves show agreement with the mass action law at high dilutions. Simple and efficient means for preparing conductivity alcohol are described. J. J. S.

2643. Conductivity of Aqueous Solutions of Salts in Presence of Neutral Molecules (Cane Sugar). H. Possner and M. Wien. *Phys. Zeits.* 30. *pp.* 161–163, *March* 15, 1929. *Paper read before the Deut. Phys. Gesell., Leipzig, Jan.*, 1929.

Salts with ions of different valencies are dissolved in concentrated sugar solution, and the equivalent conductivity for various concentrations of salt measured. For KCl, NaCl, LiCl, yielding ions of small valency, the equivalent conductivity, λ, is a linear function of the square root of the equivalent concentration, $\sqrt{m}$. For salts yielding ions of higher valency, K_2SO_4, K_3FeCy_6, etc., the linear relation only holds over a short range. Extrapolation to infinite dilution shows that for NaCl λ_∞ in the presence of sugar solution is about 2·4 % of λ_∞ in simple aqueous solution, and 0·60 % for $Ba_3(FeCy_6)_2$. The variation of conductivity with concentration is in good agreement with the Debye-Onsager theory for K_2SO_4 and K_3FeCy_6, but not for LiCl and $Ba_3(FeCy_6)_2$. A. J. M.

2644. Theory of the Complete Curve for the Wien Effect. H. Falkenhagen. *Phys. Zeits.* 30. *pp.* 163–165, *March* 15, 1929. *Paper read before the Deut. Phys. Gesell., Leipzig, Jan.*, 1929.

The Debye-Hückel theory of strong electrolytes enables the relation between electrical conductivity and frequency of alternating field to be predicted. The radius of the ionic atmosphere is in the order of $10^{-8}/\sqrt{\gamma}$ cm. and the time of relaxation $10^{-10}/\gamma$ sec. where γ = concentration in mols. per litre. Perceptible dispersion occurs if the periodic time of the field is of the same order as the relaxation time. The Wien effect occurs if an ion travels through a distance equal to the radius of its atmosphere during the relaxation time in a field E. For a uni-univalent electrolyte of concentration $\gamma = 0{\cdot}0001$ at 27° C. E is calculated to be approximately 3×10^4 volt/cm., in good agreement with Wien's results. For an electrolyte having ions of equal mobility the Debye-Hückel theory requires the relaxation force to be proportional to the velocity for low ionic velocities. With increasing field strength this relation no longer holds, and for high field strengths the relaxation force approaches a limiting value, and the conductivity increases to a value corresponding to infinite dilution. The Wien effect and the dispersion effect are shown to be intimately connected. A. J. M.